

DOCUMENT RESUME

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INSTITUTION Joint Military Packaging Training Center, Aberdeen Proving Ground, Md.

SPONS AGENCY Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.

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NOTE 397p.; Small type in diagrams and charts will not reproduce well.

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DESCRIPTORS Behavioral Objectives: *Correspondence Study; Course Descriptions: Curriculum Guides; Distributive Education: Postsecondary Education; Secondary Education: *Vocational Education

IDENTIFIERS Military Curriculum Project: *Packaging; Packers

ABSTRACT

This correspondence course on methods and techniques of packing materials and equipment for shipment and storage is designed to familiarize students with the subject matter area and to serve as a background for a more detailed and specialized study. One of a number of military-developed curriculum packages selected for adaptation to vocational curriculum and instruction, the 32-hour course consists of ten lessons, each followed by an exercise of multiple choice questions. A text assignment, lesson objective, and suggestions for the student are also given. The course covers such topics as various container types, packing materials, and techniques of packing, including blocking, bracing, cushioning, weatherproofing, and marking. The text used in the course, "Packaging of Material: Packing (Volume I)," which makes up the bulk of the document, is organized into seven chapters: packing, fiberboard and paperboard containers, wooden containers and pallets, bags and sacks, pails and drums, crates, and consolidation and unitization for shipment and use of cargo containers. A thirteen-page introduction gives an overview of packaging procedures, including the objectives of military packing, hazards encountered in transportation, handling and storage, definitions, policies, levels of protection, and suggested references. Over 300 illustrations are included in the 325 page text. (MEK)

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Military Curricula for Vocational & Technical Education

19-2



This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT Military Curriculum Materials

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Military Curriculum Materials for Vocational and Technical Education

Information and Field
Services Division

The National Center for Research
in Vocational Education



Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction	Heating & Air Conditioning
Trades	Machine Shop Management & Supervision
Clerical Occupations	Meteorology & Navigation
Communications	Photography
Drafting	Public Service
Electronics	
Engine Mechanics	

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

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DEFENSE PACKING & UNITIZATION
8B-F2

Correspondence Course 19-2

Developed by: United States Army

Occupational Area:
Warehousing and Packing

Development and
Review Dates:
March 1979

Print Pages: 380

Microfiche: 7
Availability: Vocational Curriculum
Coordination Centers

Suggested Background:

None

Target Audiences:

Grades 11 - Adult

Organization of Materials:

Lesson objectives, student exercises, text

Type of Instruction:

Individualized, self-paced

Type of Materials:

No. of Pages:

Average
Completion Time:

Introduction to Packing	8	Flexible
Packing Applications and Procedures	64	Flexible
Fiberboard Containers	35	Flexible
Wooden Containers and Pallets	46	Flexible
Miscellaneous Containers (Bags, Sacks, Drums)	22	Flexible
Crates (Wood, Steel, Aluminum)	116	Flexible
Consolidation and Unitization	26	Flexible

Supplementary Materials Required:

None



THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION

Course Description:

The course is designed to familiarize students with the packing subject matter area and to serve as a background for more detailed and specialized study. The course covers topic areas such as various containers, packing materials, and techniques of packing including blocking, bracing, cushioning weatherproofing, strapping, and marking.

DEFENSE PACKING AND UNITIZATION

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JOINT MILITARY PACKAGING TRAINING CENTER
ABERDEEN PROVING GROUND, MD.

8B-F2(COR)
DEFENSE PACKING
AND
UNITIZATION

CORRESPONDENCE COURSE



MARCH 1979

SUPERSEDES CORRESPONDENCE COURSE 8B-F2(COR), DATED MAY 1978

INSTRUCTIONS AND SUGGESTIONS TO THE STUDENT

If you will follow carefully the instructions contained herein, it will enable you to make the maximum rating commensurate with your ability, and at the same time help those who are concerned with processing your lessons to do so promptly and efficiently.

This correspondence course consists of ten lessons, each followed by a number of multiple choice questions called a lesson exercise. In addition, a final examination is required covering all ten lessons.

In the event that you do not achieve a satisfactory grade on all of your lesson exercises, you will be given a chance to resubmit those which were unsatisfactory. Therefore, it will be to your best interest to submit your lesson exercises at the earliest possible date (preferably at least two months prior to your completion). This will allow sufficient time in the event that you may have to retake one or more of your lesson exercises.

When you have achieved an average grade of satisfactory or above on your lesson exercises, you will be sent an approved solution sheet to the lesson exercises, plus the final examination. Your final examination score constitutes 50% of your final grade achieved for the correspondence course. Credit will be granted only if you have submitted both the lesson exercises and the final examination prior to the completion date that was established when you were enrolled. An extension of time may be granted if requested by you at least 30 days before the completion date.

This correspondence course is not designed to make you an expert in the subject under discussion. It is intended that from this correspondence course you will gain a familiarization with the subject that will serve either as a background for more detailed and specialized study or as a means of lessening your practical training requirements.

It is important that you follow the sequence of instruction as it is prescribed in the study guide. After you have completed the reading assignment, start working on the lesson exercise. Complete the lesson exercise before proceeding to the next lesson. Since the subject matter in the correspondence course is presented in a progressive order, a lesson frequently presupposes a knowledge of the subject previously studied. You must, therefore, retain the information learned in any one lesson in order that you may be able to complete successfully all succeeding requirements.

8B-F2(COR) DEFENSE PACKING AND UNITIZATION

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(32 Credit Hours)

The best package in the world is of no value if it reaches its destination unable to give the intended protection to the item because it lost its identity, was punctured, crushed, torn open, or otherwise damaged. It usually requires the additional protection afforded by packing. It is important to have an understanding of both packaging and packing, for only by the two working together as a team can the item receive the full protection required. In order to provide an understanding of the part that packing plays in the role of protecting military supplies and equipment, we will discuss in this subcourse various containers, packing materials, and the techniques of packing including blocking, bracing, cushioning, weatherproofing, strapping and marking.

This correspondence course consists of nine lessons, each followed by a mandatory lesson exercise. A final examination is required also. The correspondence course is organized as follows:

Lesson 1 Introduction to Defense Packing and Unitization - 2 Credit Hours

Scope--Objectives of military packing, hazards encountered, levels of packing, packing terms and definitions, and general packing operations and requirements.

Lesson 2 Packing Applications and Procedures - 4 Credit Hours

Scope--Definition, function, and application of blocking, bracing, and cushioning; description and use of blocking, bracing, and cushioning materials; weatherproofing of the pack; packing of metal containers; testing of the packs, and parcel post requirements.

Lesson 3 Fiberboard Containers - 4 Credit Hours

Scope--Description, use, classification, closure, and strapping requirements of fiberboard containers.

Lesson 4 Wooden Containers and Pallets--Part I - 4 Credit Hours

Scope--Requirements for container materials; description and classification of nailed wood boxes, cleated panel boxes, and wood cleated, skidded, load-bearing base boxes.

Lesson 5 Wooden Containers and Pallets--Part II - 2 Credit Hours

Scope--Types, classes, assembly, and selection of demountable boxes; Nomenclature, description, classes, styles, and assembly of wirebound wood boxes; and types of pallets.

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Lesson 6 Miscellaneous Containers - 3 Credit Hours

Scope--Definition and use of various types of bags, sacks, and other shipping media (baling and bundling) employed in the shipment of military supplies; description, classification, selection, and use of pails and drums.

Lesson 7 Introduction to Crates - 2 Credit Hours

Scope--Nomenclature, classification, and terms, related to crates and crate components, and the types of materials used for crate construction.

Lesson 8 Wood Crates, Open and Covered (PPP-C-650) - 3 Credit Hours

Scope--Design, fabrication, dimensions and weight limitations of open and covered crates conforming to Federal Specification PPP-C-650.

Lesson 9 Miscellaneous Crates - 4 Credit Hours

Scope--Design, classification, and fabrication requirements of open, sheathed, and slotted angle (steel or aluminum) crates conforming to Military Specification MIL-C-3774, MIL-C-104, and MIL-C-9897, respectively.

Lesson 10 Consolidation and Unitization for Shipment, and Use of Transporters - 2 Credit Hours

Scope--Requirements of palletized loads, consolidation containers, and cargo transporters.

Final Examination - 2 Credit Hours.

LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	Defense Packing and Unitization
<u>Lesson 1</u>	Introduction to Defense Packing and Unitization
<u>Credit Hours</u>	Two
<u>Text Assignment</u>	Introduction and Section I, paragraph 1-1 through 1-10.
<u>Materials Required</u>	None
<u>Lesson Objective</u>	The student will be able to identify the objectives of military packing, hazards encountered, levels of packing, packing terms and definitions, and general packing operations and requirements.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 1

EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. How is military packing defined?
 - a. Placing of individual items in packages for subsequent consolidation in shipping containers.
 - b. Placing of items or packages in shipping containers, together with blocking, bracing, or cushioning, weatherproofing, strapping, and marking for shipment.
 - c. Placing of cushioning material around items in boxes to absorb the shock encountered in shipment.
 - d. Placing of items in shipping containers.

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2. What determines the level of protection to be provided an item?
 - a. Characteristics of the item.
 - b. Climate where the item is to be stored.
 - c. Shipping, handling, and storage conditions anticipated.
 - d. Cost involved in providing protection as well as the cost of the item itself.
 3. Which situation below would be a criterion for level A protection?
 - a. Environmental exposure during transit where port and warehouse facilities are limited or nonexistent.
 - b. Controlled warehouse environmental exposure for temporary periods.
 - c. For items with characteristics that require no special or peculiar preservation-packaging and/or packing provisions.
 - d. Limited handling during transportation and intransit storage.
 4. What determines the type of load within a container?
 - a. The strength characteristics of the container.
 - b. The support provided by the contents to the container.
 - c. The type of blocking and bracing required, if any, to stabilize the load.
 - d. The expected handling, shipping, and storage hazards to be encountered.
 5. What is the military concept of economy in packing?
 - a. Make military packing more simple and easy to accomplish.
 - b. Cut down on the number of military installations engaged in packing.
 - c. Guarantee more equal distribution of packing contracts.
 - d. Provide adequate protection at the least overall cost to the Government.

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6. What term defines a document that establishes engineering and technical limitations and applications for items?
 - a. Regulation.
 - b. Standard.
 - c. Specification.
 - d. Handbook.
 7. The objective of packing is to extend the lifespan of the item so that depreciation does not start until the item:
 - a. Leaves the manufacturing plant.
 - b. Is placed in storage.
 - c. Reaches its ultimate destination.
 - d. Is actually placed into service.
 8. When is the shipping container also considered to be the unit container?
 - a. When the item is packaged and packed level C.
 - b. When the item goes directly from the manufacturer to the user.
 - c. When only one item is packed in the container.
 - d. When the exterior container is a fiberboard box.
 9. Who is responsible for the selection of an appropriate shipping container when the proper container is not specified?
 - a. Packing supervisor.
 - b. Packing engineer.
 - c. Transportation officer.
 - d. Shipping officer.

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10. When should nailed wood boxes or similar heavy wooden containers be used as the exterior pack?

- a. When the items are packed for an oversea destination.
- b. When lightweight, fragile items are shipped via other than aircraft.
- c. When the wood is desired for use by the receiving activity.
- d. When their use is fully justified by past experience or geographical considerations.

LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	Defense Packing and Unitization
<u>Lesson 2</u>	Packing Application and Procedures
<u>Credit Hours</u>	Four
<u>Text Assignment</u>	Section I, paragraphs 1-11 through 1-27
<u>Materials Required</u>	None
<u>Lesson Objectives</u>	The student will be able to identify blocking and bracing terms, application, materials and techniques; methods of anchoring and reinforcement of containers; cushioning and cushioning materials; weatherproofing the pack; packing of metal containers; testing of packs; and parcel post requirements.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 2

EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. For blocking or bracing purposes, what is an important advantage of plywood over lumber?
 - a. Plywood provides a more economical means of blocking and bracing.
 - b. Plywood is less affected by weather than lumber.
 - c. Plywood is free of knots and grain divergence.
 - d. Plywood is more resistant to splitting than lumber.

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2. What is blocking and bracing designed to accomplish in packing?
 - a. Dampen the damaging effects of shocks, jolts, and vibration transmitted to an item.
 - b. Limit the movement of certain unsecured items within the container.
 - c. Prevent any movement of the item within its container.
 - d. Provide added support to the shipping container.
3. What is the minimum clearance that should be provided around fragile parts of an item that might be damaged due to slight distortion of the container?
 - a. 1 inch.
 - b. 2 inch.
 - c. 2 1/2 inch.
 - d. 3 inch.
4. Why is corrugated fiberboard used more often than solid fiberboard when packing small, lightweight items?
 - a. Corrugated fiberboard is more weather-resistant and durable.
 - b. Corrugated fiberboard has greater cushioning value and lower cost.
 - c. Corrugated fiberboard is stronger and firmer.
 - d. Corrugated fiberboard is less flexible but more rugged.
5. Which type of bolt should not be used for blocking and bracing?
 - a. Lag bolt (lag screw).
 - b. J-bolt.
 - c. U-bolt.
 - d. Step bolt.
6. What basic factor is omitted in the following formula: $G\text{-factor} = \frac{\text{Gravity}}{\text{Mass}}$
 - a. Mass.
 - b. Distance.
 - c. Acceleration.
 - d. Time.

- //
7. Which of the following statements pertaining to cushioning is true?
 - a. Cushioning prevents any movement of the item within the container.
 - b. Cushioning materials must be strong and rugged.
 - c. Cushioning materials, regardless of use, must be chemically neutral.
 - d. Cushioning controls movement of the item within the container.
 8. What is the maximum allowable size for center knots as compared to the width of the piece of lumber to be used for blocking and bracing?
 - a. $1/8$ the width of the piece.
 - b. $1/4$ the width of the piece.
 - c. $1/2$ the width of the piece.
 - d. $3/4$ the width of the piece.
 9. What is the best way to secure a wood brace to the sides of a wooden container?
 - a. By toe nailing on all four sides.
 - b. By the use of parallel cleats.
 - c. By cutting notches into the container faceboards.
 - d. By end grain nailing.
 10. What is the minimum weight requirement for parcel post?
 - a. 4 ounces.
 - b. 8 ounces.
 - c. 12 ounces.
 - d. 16 ounces.
 11. What is the preferred placement of the load on the grain, when wood blocking and bracing is used to secure heavy items?
 - a. Edge grain.
 - b. End grain.
 - c. Face grain.
 - d. Reverse grain.

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12. When might tie rods be used for blocking and bracing applications?
 - a. When blocking and bracing numbers are of group IV wood.
 - b. When metal tie downs are required as anchors.
 - c. When the entire weight of the item thrusts against the blocking.
 - d. When standard length bolts would be too short to apply.
13. What is the main advantage of step bolts?
 - a. They have larger head dimensions.
 - b. They are stronger than other bolts.
 - c. They are easier to tighten securely.
 - d. They have threads for the attachments of lock nuts.
14. Which material would be the least desirable for the cushioning of items with highly finished metal surfaces?
 - a. Cellulosic cushioning material.
 - b. Cellular, polyvinyl chloride.
 - c. Wood excelsior in bulk form.
 - d. Fibrous glass material.
15. Which of the following cushioning materials is the least desirable for use in container which may be exposed to outdoor storage in tropical climates?
 - a. Cushioning, wrapping paperboard.
 - b. Expanded polystyrene.
 - c. Latex foam sponge rubber.
 - d. Rigid or elastic polyurethane foam.
16. What is the maximum allowable (psi) load permitted for bearing areas in flat pads of corrugated fiberboard with "B-flute"?
 - a. 2.0.
 - b. 2.5.
 - c. 3.0.
 - d. 3.5.

17. When, if ever, is decayed wood permitted as a blocking and bracing material?
- a. When less than one quarter of the piece is decayed.
 - b. Decayed wood may only be used when being nailed to a sound piece.
 - c. When the decayed portion does not weaken the wood by more than 10 percent.
 - d. Decayed wood should be avoided under all circumstances.
18. How do crate liners differ from case liners?
- a. Case liners are applied to separate panels, therefore, do not provide a continuous barrier within the container.
 - b. Crate liners are always fabricated from water-vaporproof barriers.
 - c. Case liners are only fabricated from PPP-B-1055 barrier materials.
 - d. Crate liners allow free circulation of air, while case liners are sealed.
19. Which of the following uses of waterproof barriers is considered a watershed application?
- a. Case liner.
 - b. Shroud.
 - c. Sealed wrap.
 - d. Interior wrap.
20. What test is designed to stimulate the fall of an item dropped by a man from a height to which he would normally lift the item?
- a. Free-fall drop test.
 - b. Edgewise drop test.
 - c. Over-all drop test.
 - d. Cornerwise drop test.

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LESSON ASSIGNMENT

Correspondence Course 8B-F2(COR) . . . Defense Packing and Unitization

Lesson 3 Fiberboard Containers

Credit Hours Four

Text Assignments Section II, paragraphs 2-1 through 2-4

Materials Required None

Lesson Objective The student will be able to identify the use, classification, closure, and reinforcement of fiberboard boxes (PPP-B-636) and triple-wall corrugated fiberboard boxes (PPP-B-640).

Suggestions Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 3

EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. What is the most commonly used style of fiberboard box?
 - a. Full overlap slotted (FOL).
 - b. One-piece folder (OPF).
 - c. Regular slotted container (RSC).
 - d. Full telescope container (FTC).

2. To what specification must the fiberboard material conform when used for the fabrication of fiberboard boxes?
 - a. PPP-V-205.
 - b. PPP-F-320.
 - c. PPP-B-636.
 - d. PPP-B-640.

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3. What does the "V" in the compliance symbol of a PPP-B-636 box indicate?
 - a. Very high bursting strength.
 - b. Weather-resistant fiberboard.
 - c. Vaporproof fiberboard.
 - d. Weaker than "W" fiberboard.
 4. What type of flute arrangement is generally used when the fiberboard is designed to provide a cushioning effect?
 - a. Twenty flutes, plus or minus five flutes per linear foot.
 - b. Thirty-six flutes, plus or minus three flutes per linear foot.
 - c. Forty-two flutes, plus or minus five flutes per linear foot.
 - d. Fifty flutes, plus or minus three flutes per linear foot.
 5. What is the maximum weight of box and contents (pounds) and maximum inside dimensions for class domestic, PPP-B-636 fiberboard boxes designed for special requirements?
 - a. 90 pounds, 100 inches.
 - b. 120 pounds, 110 inches.
 - c. 140 pounds, 120 inches.
 - d. 160 pounds, 120 inches.
 6. The primary advantage of solid fiberboard over corrugated fiberboard is that solid fiberboard:
 - a. Offers better cushioning effect to the contents.
 - b. Provides for greater protection when shipping fragile items.
 - c. Provides for greater resistance to rough handling and wear.
 - d. Offers a higher degree of waterproof protection.

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7. Which of the following is not a requirement for a fiberboard sleeve?
- a. It must be made of the same grade of fiberboard as the box.
 - b. The length must equal the inside width of the box.
 - c. The corrugations must be at right angles to the score lines.
 - d. It must cover the top, bottom, and both sides of the box.
8. What box dimension(s) determines the number of horizontal straps that will be placed on a fiberboard box?
- a. Length and width.
 - b. Width.
 - c. Depth.
 - d. Length.
9. How many metal straps are required for the reinforcement of a PPP-B-636 fiberboard box 2 feet in width?
- a. One.
 - b. Two.
 - c. Three.
 - d. Four.
10. What percentage of the flaps on a PPP-B-636 fiberboard box, class weather resistant, style RSC, must be covered with glue for a method III closure?
- a. 50 percent.
 - b. 75 percent.
 - c. 90 percent.
 - d. 100 percent.
11. How many staples are required to close a class weather-resistant slotted fiberboard box 20 inches wide, not hardened to equivalent of Rockwell B 90?
- a. Twenty-four.
 - b. Twenty-eight.
 - c. Thirty-two.
 - d. Thirty-six.

12. What is a necessary requirement when using nails to close triple-wall corrugated fiberboard boxes?
- a. Use double pointed zinc-coated nails, spaced 2 inches apart with a 1/8-inch clinch.
 - b. Place strips of tape over each row of nails to prevent the nails from working out of the triple-wall material.
 - c. Use nails no smaller than eightpenny, spaced at least 3 inches apart.
 - d. Use oversize washers or other devices to prevent pulling of the nail head through the triple-wall fiberboard.
13. Which of the following styles of triple-wall corrugated fiberboard boxes (PPP-B-640) are fabricated with wooden ends?
- a. Styles A and D.
 - b. Styles C and E.
 - c. Styles A and F.
 - d. Styles F and G.
14. Which style of triple-wall corrugated fiberboard box (PPP-B-640) is telescopic?
- a. A.
 - b. C.
 - c. F.
 - d. G.
15. Which style of triple-wall corrugated fiberboard box (PPP-B-640) is similar to the style RSC fiberboard box (PPP-B-636)?
- a. A.
 - b. C.
 - c. E.
 - d. G.

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16. How many styles of triple-wall corrugated fiberboard boxes (PPP-B-640) are there?
 - a. Four.
 - b. Five.
 - c. Six.
 - d. Seven.
17. To what specification should tape conform when used for sealing the joints of triple-wall corrugated fiberboard boxes (PPP-B-640) against water or dust?
 - a. PPP-T-76.
 - b. PPP-T-97.
 - c. PPP-T-45.
 - d. PPP-T-60.
18. When must triple-wall corrugated fiberboard boxes (PPP-B-640), used for commodities covered in Rule 41 of the Uniform Freight Classification, be made under a special package permit?
 - a. When they will be used for shipments sent overseas.
 - b. When they are constructed with number four wooden ends.
 - c. When they are closed by the use of nails and staples.
 - d. When the sum of the inside length, width, and depth exceed 120 inches.
19. Class 1 triple-wall corrugated fiberboard boxes (PPP-B-640) are:
 - a. Nonweather-resistant.
 - b. Easier to close than class 2.
 - c. Made with wooden ends.
 - d. Of low stacking strength.

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20. Which of the following best describes triple-wall corrugated fiberboard boxes (PPP-B-640)?

- a. Fiberboard boxes consisting of three layers of fiberboard.
- b. Boxes formed by alternating three layers of corrugated fiberboard between four layers of facing material.
- c. Fiberboard boxes formed by compressing three layers of facing material.
- d. Boxes formed by compressing three layers of paper into one corrugation between two layers of facing material.

LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	Defense Packing and Unitization
<u>Lesson 4</u>	Wooden Containers and Pallets--Part I
<u>Credit Hours</u>	Four
<u>Text Assignment</u>	Section III, paragraph 3-1 through 3-7
<u>Materials Required</u>	None
<u>Lesson Objective</u>	The student will be able to identify the requirements of container material, nailed wood boxes, cleated panel boxes, and wood cleated, skidded, loadbearing base boxes.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 4EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. Which style of nailed wood box has glued, lock-corner joints?
 - a. One.
 - b. Four.
 - c. Four and one-half.
 - d. Six.

2. Which of the following species of wood has the greatest nailing holding power?
 - a. Hickory.
 - b. Cherry.
 - c. Hemlock.
 - d. White fir.

3. Which would be considered as a wood defect for purposes of fabricating nailed wood boxes?
 - a. Wood with knot clusters.
 - b. Wood with 15 percent moisture content.
 - c. Wood with a single knot 4-1/2 inches in diameter.
 - d. Wood with the slope of grain 1 inch in 13 inches.
4. What determines the style of a nailed wood box?
 - a. The intended use of the box, whether domestic or oversea.
 - b. The weight and size limitations specified.
 - c. The arrangement of cleats on the end of the box.
 - d. The wood group from which the box is fabricated.
5. What are the domestic and oversea weight limitations (pounds) for styles 2 and 2 1/2 nailed wood boxes?
 - a. 70 and 80.
 - b. 200 and 400.
 - c. 500 and 700.
 - d. 600 and 1000.
6. What remedy is permitted when it is suspected that splitting will occur during the nailing of boxes?
 - a. Using wood that will increase the thickness by one-eighth.
 - b. Using a size smaller nail and nailing 1/4-inch closer.
 - c. Using the proper size nails and spacing twice the normal distance.
 - d. Using lubricants on nails to reduce friction.

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7. Which of the following statements applies to style 1 and style 6 nailed wood boxes?
 - a. They must always be strapped, regardless of the weight of their contents unless otherwise specified.
 - b. They are alike in construction, except that all style 1 boxes have one-piece ends.
 - c. They are constructed of group I and group II woods only.
 - d. They are limited to shipping items of low value only.
8. What term defines a wood defect when there is bark or lack of wood on the edge of a piece of wood?
 - a. Wane.
 - b. Warp.
 - c. Shake.
 - d. Split.
9. How many wood groups are there?
 - a. One.
 - b. Two.
 - c. Three.
 - d. Four.
10. Which of the following procedures is applicable when using a 10% solution on monoammonium phosphate in water for the chemically etching of nails?
 - a. Leave a portion of the solution on the nails so that a deposit will remain on them after evaporation.
 - b. First, immerse the nails in acetic acid to speed up the etching process.
 - c. Immerse the nails in the solution for about 7 hours to obtain the proper finish.
 - d. Wash nails thoroughly after etching has been completed and coat them with lightweight oil.

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11. Which style of nailed wood box is constructed with skids regardless of the weight of the contents it will carry?
 - a. Style 4.
 - b. Style 4 1/2.
 - c. Style 5.
 - d. Style 7.
12. What is the required thickness and width of cleats for a style 4 nailed wood box constructed of southern pine, for a 276-pound, type 3 (difficult) load, destined for oversea?
 - a. $1 \frac{5}{16} \times 4 \frac{1}{8}$ inches.
 - b. $\frac{13}{16} \times 2 \frac{3}{4}$ inches.
 - c. $1 \frac{1}{16} \times 3 \frac{1}{4}$ inches.
 - d. $\frac{3}{4} \times 2 \frac{1}{4}$ inches.
13. Which statement is correct concerning the use of skids on nailed wood boxes?
 - a. They are required on all boxes (except style 7) exceeding 150 pounds gross weight.
 - b. The skids shall run across the width on the bottom of the box.
 - c. The size of the skids will be determined by the gross weight of the box.
 - d. The skids shall be made from group III or IV hard woods.
14. What determines the various kinds of cleated panel boxes?
 - a. Paneling material used.
 - b. Arrangement of cleats.
 - c. Method of closing the boxes.
 - d. Wood group used in making the cleats.

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15. Which styles of cleated plywood boxes are authorized for oversea shipments?
- a. Styles A and B only.
 - b. Styles A through K inclusive.
 - c. Styles A, B, I, and J.
 - d. Styles A, B, C, and D.
16. Why are the floor boards on load-bearing base boxes separated from one another by 1/8 to 1/4 inch?
- a. To allow for shrinkage and warping of boards.
 - b. To allow for ease of inspection and checking of contents.
 - c. To allow for free circulation of air.
 - d. To allow for swelling of boards and drainage.
17. What is the maximum distance allowed between cleats on a cleated plywood box (PPP-B-601), having a type 3 load, before intermediate cleats are required?
- a. 20 inches.
 - b. 24 inches.
 - c. 30 inches.
 - d. 36 inches.
18. Which statement is true concerning wood cleated, paper overlaid veneer boxes (PPP-B-576)?
- a. Styles A and B are authorized for domestic shipments only.
 - b. When the length of the skid exceeds 10 feet, nominal 2 x 4-inch lumber must be used.
 - c. Class 1 boxes designed to carry loads up to 225 pounds should have cleats at least 1 inch thick by 2 inches wide.
 - d. Class 2 boxes are limited to a net weight of 350 pounds for types 1, 2, and 3 loads.

19. What should be the spacing of staples used to secure strapping to cleated panel boxes (PPP-B-601)?
- a. 4 inches.
 - b. 6 inches.
 - c. 8 inches.
 - d. 10 inches.
20. What determines the spacing of nails when assembling the panels of a PPP-B-601 cleated plywood box?
- a. The style of box and the weight of contents.
 - b. The type of load and thickness of the cleats.
 - c. The class and use of the box.
 - d. The size of the nails.

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LESSON ASSIGNMENT

Correspondence Course 8B-F2(COR) . . . Defense Packing and Unitization

Lesson 5 Wooden Containers and Pallets - Part II

Credit Hours Two

Text Assignment Section III, paragraphs 3-8 through 3-12

Materials Required None

Lesson Objective The student will be able to identify the requirements of demountable wirebound wood boxes, slack wood barrels, pallets, and consolidation containers.

Suggestions Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 5

EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this corresponding course, not on your experience, opinions, or future changes.

1. What is the weight limitation of a class 1 domestic PPP-B-585 wirebound wood box?
 - a. 300.
 - b. 400.
 - c. 500.
 - d. 600.
2. When is strapping applied to wirebound boxes?
 - a. Either before or after closure.
 - b. Wirebound boxes are not strapped.
 - c. After the wires are twisted or looped.
 - d. Before the wires are twisted or looped

3. What determines the styles of wirebound wood boxes?
 - a. Type of material from which the boxes are constructed.
 - b. Method of closure used to shut the boxes.
 - c. Type of contents the boxes are designed to carry.
 - d. Number of reinforcing straps used and the method of application.
4. What must be done before using wirebound wood boxes received from the manufacturer?
 - a. Staple the wire to the boards.
 - b. Test them to see if they meet Government specifications.
 - c. Inspect the security of the the fastenings used for closure.
 - d. Set them up for the item to be shipped.
5. Which of the following is an advantage of wirebound wood boxes?
 - a. They have a high resistance to distortion.
 - b. They are easy to stencil.
 - c. They have good stacking strength.
 - d. They provide economy through low initial cost.
6. What component is used on wirebound wood boxes to reinforce the ends and cleats, and increase the stacking strength of the box?
 - a. Liners.
 - b. Subcleats.
 - c. Binding wires.
 - d. Battens.
7. What is the maximum number of pounds wirebound wood boxes can carry under normal oversea conditions?
 - a. 300 pounds.
 - b. 400 pounds.
 - c. 500 pounds.
 - d. 600 pounds.

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8. What type(s) of loads are permitted for shipment in wirebound wood boxes?
 - a. Type 1 only.
 - b. Types 1 and 2 only.
 - c. Types 2 and 3 only.
 - d. Types 1, 2, and 3.
9. The normal size for general purpose pallets is?
 - a. 36" x 40".
 - b. 40" x 42".
 - c. 40" x 48".
 - d. 48" x 50".
10. Which of the following statements is true concerning special purpose pallets?
 - a. Their initial cost is much less than general purpose pallets.
 - b. They are designed for one time and one way usage.
 - c. They are more rugged than general purpose pallets.
 - d. They are constructed of lightweight materials, such as plywood.

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LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	Defense Packing and Unitization
<u>Lesson 6</u>	Miscellaneous Containers
<u>Credit Hours</u>	Three
<u>Text Assignment</u>	Section IV and V, paragraphs 4-1 through 5-8
<u>Materials Required</u>	None
<u>Lesson Objective</u>	The student will be able to identify the various miscellaneous containers, such as bags, sacks, drums, pails, bundles, and bales.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 6

EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. What factor determines the TYPES of the textile, burlap, cotton, and waterproof laminated bags?
 - a. The kind of material that is used for the inside layer of the bags.
 - b. The manner in which the bags are sewn.
 - c. The order of the layers of material of which the bags are made.
 - d. The material used on their construction.

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2. Which PPP-D-723 fiber drum would be used to ship a semiliquid product in a normal oversea shipment?
 - a. Type I, grade A.
 - b. Type II, grade B.
 - c. Type III, grade C, class 2.
 - d. Type III, grade D.
3. What is the purpose of the internal locking rings in a MIL-D-6054 metal drum?
 - a. Provide a water-vaporproof seal on the lid.
 - b. Facilitate internal blocking and bracing.
 - c. Reinforce the rolling hoops.
 - d. Prevent pilferage.
4. Cotton mailing bags are closed by?
 - a. Taping.
 - b. Sewing.
 - c. Drawstring.
 - d. Stapling.
5. What is the difference, if any, by definition between a bag and a sack?
 - a. Bags are normally larger than sacks.
 - b. Bags are used for shipping items weighing less than 5 pounds.
 - c. Sacks are large bags designed to carry materials other than food stuffs.
 - d. Sacks are considered to be the same as heavy duty bags.
6. What is a distinguishing feature of wet strength kraft paper?
 - a. Polyethylene lining on one side.
 - b. Paper creped in one direction only.
 - c. Paper creped in one direction and pleated in the other.
 - d. Longitudinal red strips 1/8 inch wide, spaced 2 inches apart.

7. Why should polyethylene drums (MIL-D-40030) be protected from exposure to sunlight?
 - a. Sunlight causes discoloration of polyethylene.
 - b. Sunlight causes decomposition of the contents within the container.
 - c. Sunlight produces ultraviolet rays which accelerate aging of the polyethylene.
 - d. Sunlight produces gas build-up in containers that will cause rupture of the polyethylene.
8. When may nonreturnable containers (PPP-P-704) be reused, if ever, for returned shipments?
 - a. Nonreturnable containers (PPP-P-704) are to be used as single-trip containers only.
 - b. They may be reused if they are to carry noncorrosive liquids.
 - c. They may be reused to carry the same type of materials which they carried originally.
 - d. They must be retested and approved by the Bureau of Explosives before reuse.
9. What is the size of a PPP-D-705, type V drum?
 - a. 16 gallons.
 - b. 30 gallons.
 - c. 35 gallons.
 - d. 55 gallons.
10. Which type of container may be closed by the use of the bolted ring closure?
 - a. Plastic polyethylene drums (MIL-D-40030).
 - b. Metal shipping and storage drums (MIL-D-6054).
 - c. Fiber drums (PPP-D-723).
 - d. Steel shipping pails (PPP-P-704).

LESSON ASSIGNMENT

<u>Correspondence Course</u>	8B-F2(COR) . . .	Defense Packing and Unitization
<u>Lesson 7</u>		Introduction To Crates
<u>Credit Hours</u>		Two
<u>Text Assignment</u>		Section VI, paragraphs 6-1 through 6-2
<u>Materials Required</u>		None
<u>Lesson Objective</u>		The students will be able to identify the nomenclature and related terms associated with crates and crate construction.
<u>Suggestions</u>		Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 7EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. When is the sill-base crate used to ship an item?
 - a. Item is too heavy for a skid-base crate.
 - b. Item is flat on the bottom.
 - c. Item is extremely fragile.
 - d. Item mounting facilities are not at the lowest point.
2. How do wood requirements for crates compare to those for nailed wood boxes?
 - a. Wood for crate construction must meet more rigid standards.
 - b. Almost any type of wood is permitted for crate construction.
 - c. Knot requirements are not as rigid for crate materials.
 - d. Wood used for crates or wood boxes must meet the same high standards.

3. What is the primary purpose of the covering on an unsheathed crate?
 - a. Provide a better marking surface.
 - b. Increase ease of handling and storage operations.
 - c. Provide protection against the elements.
 - d. Shelter classified items from view.
4. What should be the moisture content of lumber used to construct wooden crates?
 - a. Absolutely dry.
 - b. 2 to 5 percent.
 - c. 8 to 19 percent.
 - d. 12 to 19 percent.
5. When may diagonals be eliminated from crate construction?
 - a. When the crate is for domestic use.
 - b. When the item weighs less than 100 pounds.
 - c. When plywood sheathing is used.
 - d. When the crate is of bolted construction.
6. When is the use of lag bolts (screws) prohibited in crate construction?
 - a. When using soft wood as the crate material.
 - b. When tying the floorboards to the skids.
 - c. When assembling the sides of the crate to the ends.
 - d. When assembling the sides, ends, and tops of demountable crates.
7. What should be the diameter of the lead hole in a piece of group IV wood if the lag bolt (screw) to be used has a threaded portion 3/4-inch in diameter.
 - a. 3/16-inch.
 - b. 1/4-inch.
 - c. 1/2-inch.
 - d. 5/8-inch.

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8. What is the primary reason for the establishment of size and weight limitations for crates?
 - a. Insure crate compatibility with transportation and handling gear.
 - b. Allow for height of ceilings and thickness of floor limitations in warehouses.
 - c. Permit any crate to be carried in all types of cargo aircraft.
 - d. Eliminate the need for reinforcing the crates basic structural members.
9. A square piece of plywood placed at the junction of the diagonals for reinforcement is defined as a:
 - a. Buffer square.
 - b. Kick block.
 - c. Center brace.
 - d. Gusset plate.
10. Why are lag bolt reinforcing straps used in the construction of many demountable crates?
 - a. The use of the crate and the fragility of the contents.
 - b. The weight and size of the crate.
 - c. To hold the sides and ends together.
 - d. To prevent the lag screws from tearing through the sheathing as the crate is lifted.

LESSON ASSIGNMENTCorrespondence Course 8B-F2(COR) . . . Defense Packing and UnitizationLesson 8 Wood Crates, Open and Covered (PPP-C-650)Credit Hours ThreeText Assignment Section VI, paragraphs 6-3 through 6-11Materials Required NoneLesson Objective The student will be able to identify the requirements of Wood Crate, Open and Covered (PPP-C-650)Suggestions Read the text assignment prior to completing the exercises.8B-F2(COR) - LESSON 8EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. How are crates under specification PPP-C-650 classified?
 - a. According to the type of wood, size, and use of crate.
 - b. According to the weight requirements, size, and construction.
 - c. According to the method of assembly and materials used.
 - d. According to the crate design and construction of base.
2. When may forklift truck openings serve as sling openings on type I, style A, PPP-C-650 crates?
 - a. When the crate is less than 5 feet long.
 - b. When the skids are constructed of 4 x 4 lumber.
 - c. When load-bearing floor members are 12 inches apart.
 - d. When the center piece of the rubbing strip is 8 inches long.

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3. Where shall the forklift openings be located on a crate?
 - a. At the center of the item within the crate.
 - b. At the center of balance of the loaded crate.
 - c. At the center of gravity of the loaded crate.
 - d. At the center of the loaded crate.
4. Which type and style of PPP-C-650 crate may be either open or covered?
 - a. Type I, style A.
 - b. Type I, style B.
 - c. Type V, style A.
 - d. Type V, style B.
5. Which type of PPP-C-650 crate is limited to a maximum inside dimension of 12 feet length 4 feet width and 2 feet height?
 - a. Type I.
 - b. Type II.
 - c. Type III.
 - d. Type IV.
6. What must be the minimum actual thickness of the load bearing floorboards (inches) if the load is 229 lbs per inch of floorboard width, with skids placed 30 inches apart?
 - a. 2 inches.
 - b. 3 inches.
 - c. 4 inches.
 - d. 5 inches.

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7. What is the allowable load (pounds) per inch of floorboard width for an open PPP-C-650 crate, constructed from group II wood, with load-bearing floorboards 4 inches thick, and with skids spaced 5 feet apart?
 - a. 182.
 - b. 219.
 - c. 313.
 - d. 382.
8. What is the allowable load (pounds) per inch of floorboard width for a sheathed PPP-C-650 crate, fabricated from group IV wood, with load bearing floorboards 3 inches thick, and with skids spaced 3 feet apart?
 - a. 164.
 - b. 192.
 - c. 230.
 - d. 313.
9. What part of the crate is designed with provisions for handling by slings and forklift trucks?
 - a. Load-bearing members.
 - b. Skids.
 - c. Rubbing strips.
 - d. Base assembly.
10. What is the preferred angle of the diagonals to the side on a type II, style A, PPP-C-650 crate?
 - a. 15 degrees.
 - b. 30 degrees.
 - c. 45 degrees.
 - d. 60 degrees.

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11. What type of items are normally shipped in PPP-C-650 open crates?
 - a. Lightweight metal items.
 - b. Unclassified fragile items.
 - c. Items with mounting facilities.
 - d. Items of rugged construction.
12. What is a requirement for interior shrouds used for water shed protection of items packed in open crates?
 - a. Shroud must be made of transparent plastic material.
 - b. Shroud shall be completely sealed at the top, bottom, and sides.
 - c. Shroud must be fabricated of water-vaporproof barriers.
 - d. Shroud shall be open at bottom to permit free air circulation.
13. What is the primary difference between the type II, style A and style B PPP-C-650 crates?
 - a. Style B is plywood sheathed only.
 - b. Style A may be either open or covered.
 - c. Style B is lumber sheathed only.
 - d. Style A has greater size and weight limitations.
14. Why are interior side battens replaced by exterior side cleats for type II, style B, light duty PPP-C-650 crates specified for net loads over 200 pounds?
 - a. Prevent the weight of the contents from rupturing the sides.
 - b. Permit forklift handling of crates on their sides.
 - c. Permit the use of larger nails for stronger crate construction.
 - d. Allow for notches to be cut in sides for handling with slings.

15. What determines the size and weight restrictions for type III, style B, PPP-C-650 light duty crates?
 - a. Construction, whether open or covered.
 - b. Destination, whether domestic or oversea.
 - c. Handling equipment to be used.
 - d. Type of item(s) to be shipped.
16. What is an alternate method of assembling the top, side, and end panels of type V, style A, PPP-C-650 heavy duty bolted crates?
 - a. Using closure plates and corner strapping.
 - b. Applying strapping around all panels.
 - c. Using spring clamp fasteners.
 - d. Nailing panels to each other.
17. What is the required size (inches) for all frame members of type I, style B, light duty PPP-C-650 crates designed to carry a net load of 150 pounds?
 - a. 1 x 2.
 - b. 1 x 3.
 - c. 1 x 4.
 - d. 1 x 6.
18. What other container ends are the lumber ends of a type II, style A crate (PPP-C-650) very similar to in construction?
 - a. Style A triple-wall fiberboard box.
 - b. Style 4 nailed wood box.
 - c. Style B cleated panel box.
 - d. Style 5 nailed wood box.

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19. What type of fasteners should be used to fasten the crate unit to the skids and end cross members of a type V, style A, class 2, heavy duty crate (PPP-C-650)?
- a. Nails.
 - b. Lag bolts (screws).
 - c. Tie bolts.
 - d. Step bolts.
20. What must be done to the plywood sides when the type II, style A crate is too long for a single piece to be used?
- a. Join the pieces together with a butt joint at an intermediate batten.
 - b. Apply a 2 inch strip of waterproof tape to the entire width of the seam where the pieces join together.
 - c. Lap the pieces of plywood one over the other and staple forming a lap joint.
 - d. Nail a strip of 2 inch wide lumber at the seam where the pieces meet using a staggered pattern.

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LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	Defense Packing and Unitization
<u>Lesson 9</u>	Miscellaneous Crates
<u>Credit Hours</u>	Four
<u>Text Assignment</u>	Section VI, paragraphs 6-12 through 6-18
<u>Materials Required</u>	None
<u>Lesson Objective</u>	The student will be able to identify the requirements of open, sheathed, and slotted angle crates conforming to MIL-C-3774, MIL-C-104, and MIL-C-9897.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 9EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. Which best describes a type I, style B crate conforming to specification MIL-C-9897?
 - a. An open crate without skids.
 - b. A covered crate without skids.
 - c. An open crate with skids.
 - d. A covered crate with skids.
2. How should floorboards 6 inches wide be fastened to the skids of open bolted crates (MIL-C-3774)?
 - a. Three or more sixteenpenny nails in each skid.
 - b. Six twentypenny nails placed in each skid.
 - c. One bolt in each skid.
 - d. Two bolts in each skid.

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3. What factors determine the size and number of bolts to be used when fastening the side panels to the base of a MIL-C-3774 crate?
 - a. Weight of contents, size of wood members, and wood group used.
 - b. Gross weight of crate, crate dimensions, and type of wood used.
 - c. Tare weight of crate, size of skids, and thickness of lumber used.
 - d. Weight of contents, thickness of skids, and width of side panels used.
4. How many crate designs may be constructed according to the provisions of specification MIL-C-104?
 - a. Two.
 - b. Four.
 - c. Six.
 - d. Eight.
5. What factor determines the amount of ventilation to be provided in a sheathed crate?
 - a. Gross weight of crate.
 - b. Type of crate top used.
 - c. Volume of crate.
 - d. Total outside area of crate.
6. What specification covers crates that are specially designed to carry lightweight airframe components?
 - a. MIL-C-104.
 - b. MIL-C-3774.
 - c. MIL-C-9897.
 - d. PPP-C-650.

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7. What type of framing pattern is used on the top of a MIL-C-3774 crate 5 feet wide?
- a. N.
 - b. X.
 - c. HK.
 - d. A.
8. How many "X" panels would be required for the top of a MIL-C-3774 crate 16 feet long and 4 feet wide?
- a. Two.
 - b. Three.
 - c. Four.
 - d. Five.
9. When may the number of bolts used to fasten diagonals to skids be reduced by one-half on the MIL-C-3774 crates?
- a. When skids are made from group IV wood.
 - b. When connector plates are used.
 - c. When the diagonals are placed at an angle of 30 degrees.
 - d. When initial assembly is done by nailing.
10. What is the minimum height required for a MIL-C-3774 bolted crate 36 feet long?
- a. 6 feet.
 - b. 8 feet.
 - c. 10 feet.
 - d. 12 feet.
11. What is the recommended gross weight for a MIL-C-104 sheathed wood crate?
- a. 11,200 pounds.
 - b. 15,300 pounds.
 - c. 20,000 pounds.
 - d. 30,000 pounds.

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12. What is a requirement when drilling holes for perimeter ventilation in a MIL-C-104 crate?
 - a. Drill holes in a circular pattern spaced 1/2-inch apart.
 - b. Place holes in cluster as near the top of the crate as possible.
 - c. Place holes in clusters near the upper frame members and provide with a baffle.
 - d. Drill holes in a straight line at a 45 degree angle to drain outward.
13. How many 1/2 x 6 inch lag bolts (screws) would be required for assembling each side to the base of a bolted MIL-C-3774 crate, designed to carry 6,000 pounds, where group I, nominal 1-inch longitudinal members are used in the sides, and nominal 4-inch wide skids are used in the base?
 - a. Twenty.
 - b. Eighteen.
 - c. Fourteen.
 - d. Ten.
14. When is a two-X frame pattern required for end panels of a MIL-C-3774 crate?
 - a. When diagonal members are less than 1 x 6 inch material.
 - b. When the X frames are fabricated of group I or II woods.
 - c. When the width of the crate is equal to the height.
 - d. When the width of the crate is 1 1/2 times the height.
15. What is a requirement when using lag bolts (screws) to assemble bolted crates (MIL-C-3774)?
 - a. Lag bolts must be countersunk by at least 1/8 inch.
 - b. Washers must be used under the heads of the lag bolts.
 - c. Washers must be placed under both the heads and the nuts.
 - d. Lag bolts must be spaced at least 24 inches apart.

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16. What are the normal size limitations of a MIL-C-104 crate?
- a. 30 feet in length, 9 feet in width, and 10 feet in height.
 - b. 30 feet in length, 10 feet in width, and 9 feet in height.
 - c. 40 feet in length, 9 feet in width, and 10 feet in height.
 - d. 40 feet in length, 10 feet in width, and 10 feet in height.
17. Which metals may be used to form the framework for slotted angle crates (MIL-C-9897)?
- a. Steel or magnesium.
 - b. Aluminum or beryllium.
 - c. Steel or aluminum.
 - d. Molybdenum or magnesium.
18. What is the purpose of placing a carriage bolt crosswise 2 or 3 inches, back from each end of the skid on open bolted crates (MIL-C-3774)?
- a. Prevent splitting of the end of the skid.
 - b. Provide a means of extending headers if required.
 - c. Provide reinforcement to the skids and rubbing strips.
 - d. Eliminate the need for 45 degree angle bevels.
19. When must the load-bearing members and floor members of a MIL-C-104 sheathed wood crate be dressed?
- a. When carrying items with critical metal surfaces.
 - b. When the barrier material of items within floating bags come in contact with the crate floor.
 - c. When items within the crate constitute a floating load.
 - d. When the items to be carried are too fragile to be held in place by wood blocking and bracing.

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20. What determines the style of a MIL-C-104 crate?

- a. Type of base (skid or sill base).
- b. Type of construction (open or covered).
- c. Type of covering (lumber or plywood).
- d. Type of assembly (nailed or bolted).

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LESSON ASSIGNMENT

<u>Correspondence Course 8B-F2(COR)</u>	.. Defense Packing and Unitization
<u>Lesson 10</u>	Consolidation and Unitization For Shipment, and Use of Transporters
<u>Credit Hours</u>	Two
<u>Text Assignment</u>	Chapter 7, paragraph 7-1 through 7-15
<u>Materials Required</u>	None
<u>Lesson Objective</u>	The student will be able to identify the requirements of palletized loads, consolidation containers, and cargo transporters.
<u>Suggestions</u>	Read the text assignment prior to completing the exercises.

8B-F2(COR) - LESSON 10EXERCISES

All exercises for this lesson are of equal weight.

Requirement - Each multiple choice exercise has four possible answers. Decide which one of the four answers is the best and then indicate your choice by marking an "X" through the appropriate letter on the answer sheet. Your answers must be based on materials furnished with this correspondence course, not on your experience, opinions, or future changes.

1. What publication contains regulations for the loading of unitized loads on pallets?
 - a. MIL-P-3938.
 - b. MIL-P-15011.
 - c. MIL-STD-147.
 - d. MIL-STD-731.
2. What is the gross weight of a load that can be shipped on a pallet?
 - a. 5,000 pounds.
 - b. 4,000 pounds.
 - c. 3,000 pounds.
 - d. 2,000 pounds.

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3. A type III consolidation insert container is made of:
 - a. Plywood.
 - b. Fiberboard.
 - c. Plywood wirebound.
 - d. Lumber.
4. Where should heavy items be placed when packing a consolidation container?
 - a. To one side and on the bottom.
 - b. In the center and on the bottom.
 - c. Near the bottom.
 - d. Near the side.
5. Which of the following would not be considered a "cargo transporter"?
 - a. Seavan.
 - b. Fiberboard boxes.
 - c. Conex.
 - d. Milvan.
6. What is the weight carrying capacity for a type II Conex transporter?
 - a. 1,000 pounds.
 - b. 5,000 pounds.
 - c. 9,000 pounds.
 - d. 11,000 pounds.
7. What is the gross weight that can be shipped in a 20-foot Milvan?
 - a. 44,800 pounds.
 - b. 24,800 pounds.
 - c. 64,800 pounds.
 - d. 34,800 pounds.

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8. What is considered to be the standard length of a Seavan, utilized by the military?
 - a. 40 foot.
 - b. 20 foot.
 - c. 35 foot.
 - d. 25 foot.
9. May food or medical supplies be loaded in the same transporter with hazardous materials?
 - a. No.
 - b. Yes.
 - c. Sometimes.
 - d. Whenever practicable.
10. What military specification governs the marking of Milvans and Seavans?
 - a. MIL-STD-931.
 - b. MIL-STD-129.
 - c. MIL-STD-248.
 - d. MIL-STD-731.

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AFP 71-16
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PACKAGING OF MATERIEL

PACKING

(VOLUME II)

DEFENSE LOGISTICS AGENCY
DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
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WASHINGTON, D.C., 15 June 1977

PACKAGING OF MATERIEL

PACKING (VOLUME II)

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INTRODUCTION

1. Purpose and Scope

a. Purpose. This publication contains information on the fundamental principles and approved methods and techniques used in the protection of military supplies and equipment against deterioration and damage during shipment and storage. It is published as an official document for use in operations and in the training of military and civilian personnel from all segments of the Department of Defense and supporting agencies, as well as for interested industrial personnel. It contains information based on specifications, standards, and other pertinent documents, current as of the date of preparation and coordination of the publication.

Note. For Air Force use, this publication is nondirective in nature.

b. Scope. This manual complements Volume I, Packaging of Materiel, to emphasize the importance of packing of military supplies and equipment. It contains detailed information concerning the requirements to accomplish packing operations. The requirements include use of exterior shipping containers; the assembling of items or packs into the container; anchoring, blocking, bracing, and cushioning of items or packages within the container; weatherproofing; strapping of containers; the testing of exterior packs; palletized and unitized loads; parcel post; and related subject matter. General exterior marking in accordance with MIL-STD-129 is discussed. Carloading is not included to avoid unnecessary duplication of the Association of American Railroad publications.

2. Changes and Revisions

a. Changes or revisions to this manual, due to major changes in packing concepts, policies and doctrine, and revision of specifications and other official publications, will be made on a continuing basis, as required. Information contained herein is current as of 31 August 1976.

b. Users are encouraged to submit recommended changes or comments to improve this manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be pro-

vided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or appropriate service form and forwarded direct to Director, Joint Military Packaging Training Center, Aberdeen Proving Ground, MD 21005.

3. Objectives of Military Packing

The objectives for achieving uniform packing of items of military supply are to—

a. Insure optimum life, utility and performance of materiel through prevention or deterioration or damage.

b. Support the materiel readiness posture of DOD.

c. Provide for efficient receipt, storage, inventory, transfer and issue of materiel.

d. Assure that marking requirements are kept at the minimum necessary for effective identification, handling shipment and storage.

e. Effect economies by requiring the use of packs which yield lowest overall cost to the total DOD distribution system consistent with known or anticipated shipment, handling and storage conditions. Considerations will include—

(1) Standardization to minimum variety of materials, methods of preservations, and documentation.

(2) Accomplishment with optimum amount of automated operations.

(3) Minimum weight and cube.

(4) Use of modular containers.

(5) Handling by unitized load configuration.

(6) Use of containerization.

(7) Exploitation of new materials, methods, and techniques.

(8) Disposability of packaging materials.

4. Hazards Encountered in Transportation, Handling, and Storage

Military supplies and equipment must be protected against pilferage and damage due to force

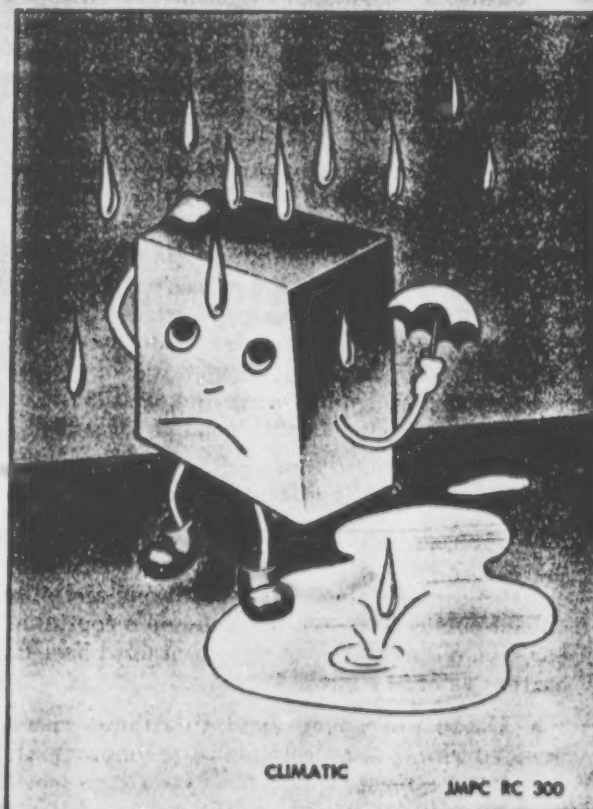
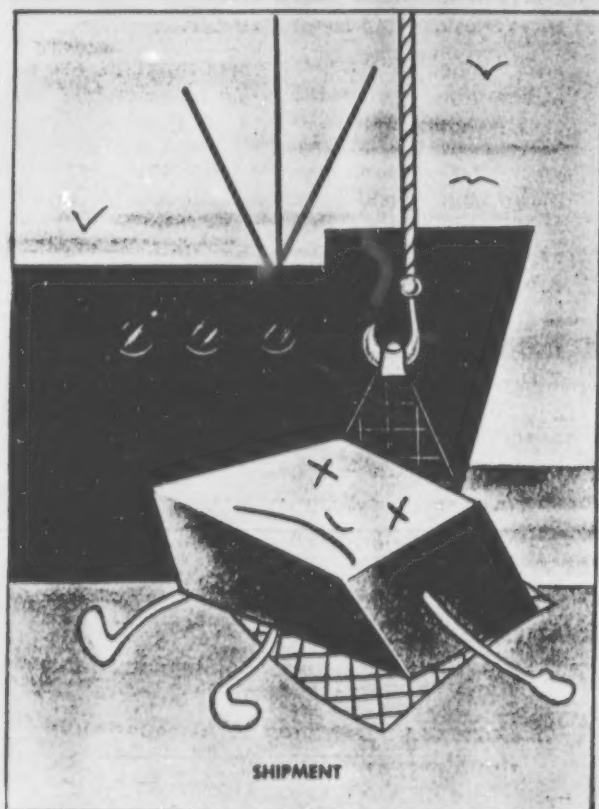
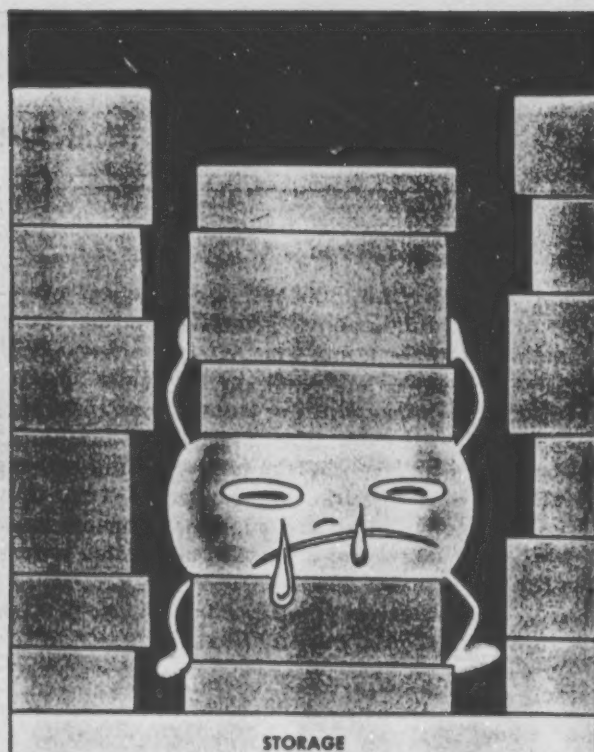
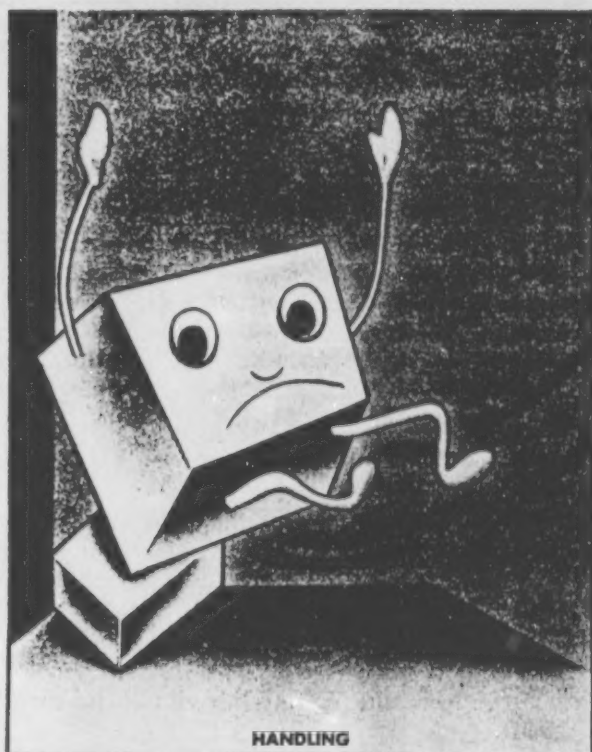


Figure 1. Hazards encountered by military packs.

and exposure, not only until they reach their ultimate destination, but until the items are placed into actual use or service. Force and exposure will reduce the useful lifespan of the item or cause the item to be damaged beyond repair. The objective of packing is to extend the lifespan of the item so that depreciation starts, not when it leaves the manufacturing plant, but when it is placed into service.

a. Force. Damage may result from hazardous forces encountered in transportation, handling, and storage (fig 1).

(1) Transportation hazards involve forces encountered through rail, truck, boat, or air shipments.

(a) Damage can result from abrupt starts and stops.

(b) Damage can be caused by vibration and jolting.

(2) Handling forces involve those damaging forces received through loading, unloading, and handling during storage operations. Examples of handling where damage often occurs are—

(a) Manual handling—dropping and puncture.

(b) Forklift truck handling—dropping and puncture.

(c) Cargo nets—dropping, crushing, and wracking.

(d) Grab hooks—crushing and puncture.

(e) Slings—crushing, dropping, and wracking.

(f) Conveyors—jarring, smashing, and dropping.

(3) Storage forces involve those forces resulting from the crushing effect of superimposed loads through stacking.

b. Exposure. Exposure to the different climatic conditions and weather hazards, such as high humidity, rain, salt spray, extreme cold, dry intense heat, and the cycling of these weather conditions, will tend to accelerate the breakdown or deterioration of unprotected items.

c. Pilferage. Theft of military supplies and equipment while in transit or storage is a significant problem for the military. Small items of high value are especially vulnerable to pilferage and should be protected as much as possible through packing techniques. If equipment or supplies are especially susceptible to pilferage see section IV FM 19-30.

d. Counteraction of Packs to Hazards. Items

which are packed properly will resist the damaging effects of force and exposure.

(1) Force is counteracted by—

(a) Using rigid shipping containers.

(b) Immobilizing the item within the container through anchoring, blocking, and bracing.

(c) Damping forces through the use of cushioning materials and devices.

(d) Reinforcing shipping containers with metal and nonmetallic strapping.

(2) Exposure is counteracted by the use of—

(a) Weather-resistant shipping containers.

(b) Waterproof barrier materials in various applications.

5. Necessity for a Packing Policy

To attain economy, efficiency, and uniformity in packing, and to provide a uniform procedure in connection with procurement, the departments and agencies of the Department of Defense must have a common packing policy. This is provided by the Department of Defense in Department of Defense Instruction 4100.14, "Packaging of Material."

6. Military Regulations

Department of Defense Instruction 4100.14 is implemented by a joint regulation developed by the Department of the Army in coordination with the Defense Logistics Agency, the Department of the Navy, the Department of the Air Force, and the Marine Corps (AR 700-15/NAVSUPINST 4030.28A/AFR 71-6/MCO 4030.33A/DLAR 4145.7). This document provides guidance for the development of service preservation, packing and marking requirements to be included in specifications and procurement documents. It is not referenced in contracts, specifications or other instruments for negotiation with industry.

7. Military Packaging Levels of Protection and Commercial Packaging

a. Concept of Military Levels. In regard to requirements for packing, the military services for many years relied heavily on the terms "domestic" and "overseas." Experience proved that for military purposes, these words were vague generalities with no clear-cut meaning to them. Suppliers were often perplexed when confronted with overseas requirements for items destined for domestic installations. It was not apparent to them that the domestic destinations were merely initial receiving points for projected overseas shipments,

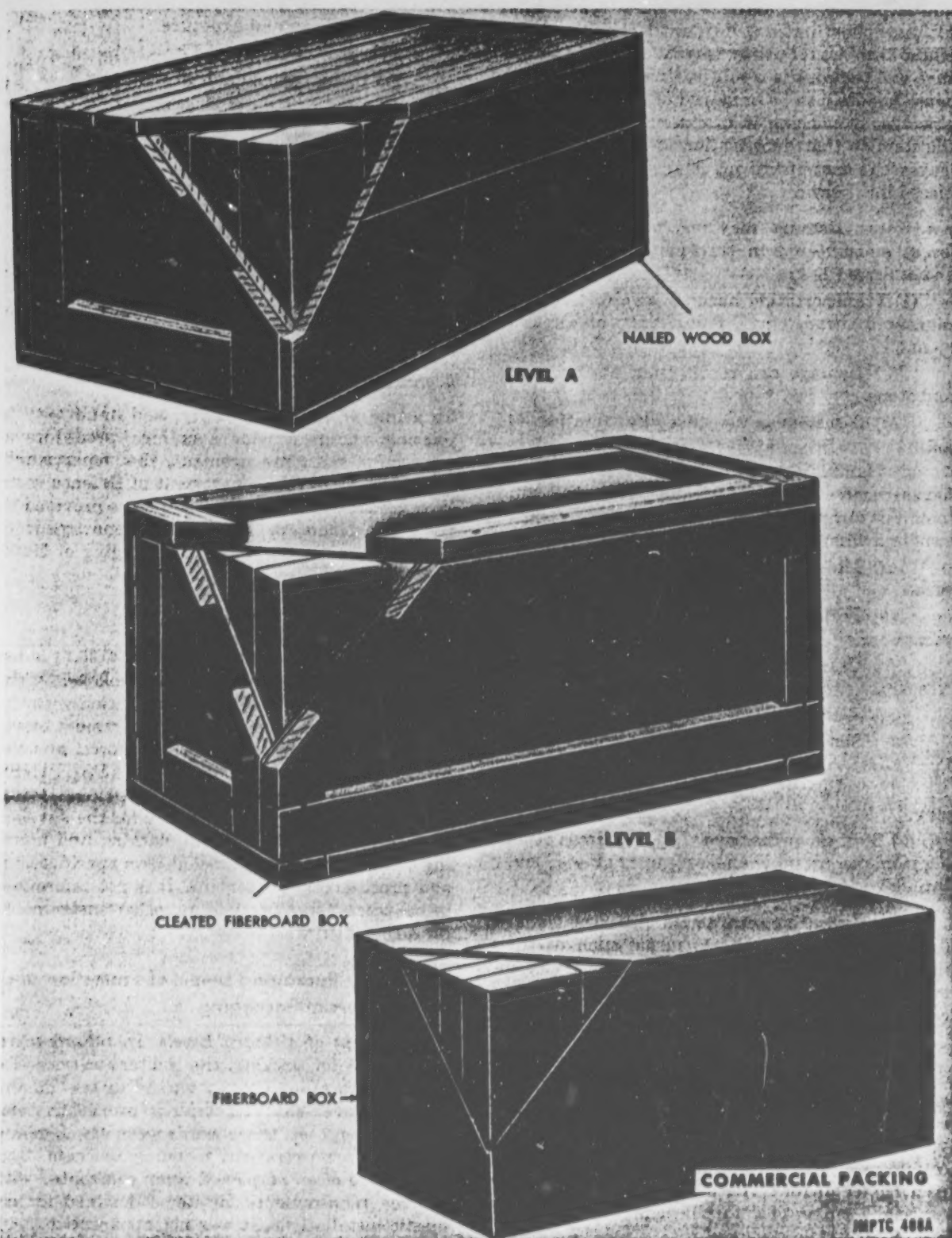


Figure 2 Examples of levels of protection and commercial packaging.

or that storage and handling conditions were severe enough to justify an oversea type of packing regardless of destination. To permit the military services to state their requirements more objectively, the concept of levels was adopted. The level selected shall be adequate, but not in excess, to assure delivery of supplies to the user in satisfactory condition (fig 2). The following levels of protection apply equally to preservation and packing:

(1) *Level A (maximum military protection).* Level A is the degree of preservation or packing required for protection of materiel against the most severe conditions known or anticipated to be encountered during shipment, handling, and storage.

(2) *Level B, (minimum military protection).* Level B is the degree of preservation or packing required for protection of materiel under known favorable conditions during shipment, handling and storage.

b. Commercial Packaging. Commercial packaging may be utilized whenever logistical conditions justify and may also be used to satisfy level A or B requirements whenever the technical design details of the package meet all conditions of the level of protection specified. Commercial packaging must protect items against physical and environmental damage during shipment, handling and storage.

c. Concept of Federal Levels (Nonmilitary). For requirements concerning packing levels for Federal commodities used by Federal agencies, see FED-STD-102.

8. Application of the Levels of Protection and Commercial Packaging

a. Determining Factors. Application of the levels of protection is based upon the nature of the item and the extent of protection required to meet the shipping, handling, and storage hazards expected.

b. Guidelines. For the judicious establishment of requirements for level A, B, or commercial packaging to be included in specifications, invitations for bids, contracts, orders, etc., the military services have agreed upon the following guidelines:

(1) *Level A.*

(a) Multiple handling during transportation and intransit storage from point of origin to ultimate user.

(b) Shock, vibration and static loading during shipment.

(c) Loading on shipdeck, transfer at sea, helicopter delivery and offshore or over-the-beach discharge, to ultimate user.

(d) Environmental exposure during shipment or during intransit operations where port and warehouse facilities are limited or non-existent.

(e) Extended open storage in all climatic zones.

(f) Static loads imposed by stacking.

(2) *Level B.*

(a) Multiple handling during transportation and intransit storage.

(b) Shock, vibration and static loading of shipment worldwide by truck, rail, aircraft, or ocean transport.

(c) Favorable warehouse environment for extended periods.

(d) Environmental exposure during shipment and intransit transfers, excluding deckloading and offshore cargo discharge.

(e) Stacking and supporting superimposed loads during shipment and extended storage.

(3) *Commercial packaging.*

(a) Items will be given the best degree of protection employed by the supplier to afford protection against corrosion, deterioration, and damage during shipment.

(b) Protection will be that used for distribution directly to a using customer.

(c) Wholesale assembly bulk type practices such as are used in inter- and intraplant shipments or shipments to jobbers are not acceptable, unless they are the usual trade practices for selected commodities; e.g., petroleum, coal, and textiles.

(d) The requirements will be incorporated in standardization and procurement documents when applicable.

9. Standard Definitions

The definitions for the key packing terms used in this volume will be found in Federal Standard No. 75, "Glossary of Packaging Terms." Technical progress and understanding among interested Government agencies, industrial concerns, and individuals are greatly facilitated when use is made of basic terms which have been standardized.

10. Other Definitions

a. Bolting Down. The securing of an item to the base of a shipping container by means of bolts

applied through regular mounting holes in the item. One of several forms of anchoring.

b. Commercial Packaging. The methods and materials employed by the supplier to satisfy the requirements of the commercial distribution system.

c. Containerization. The use of an article of transport equipment designed to facilitate and optimize the carriage of goods by one or more modes of transportation without intermediate handling of the contents.

d. End Grain. Either of the two surfaces exposed when a piece of lumber is cut crosswise (across the grain).

e. Exterior Pack. A container, bundle, or assembly which is sufficient by reason of material, design and construction to protect materiel during shipment and storage. This can be the unit pack or a container with any combination of unit or intermediate packs.

f. Fragility. The inherent physical properties of an item that limit its ability to withstand shock or vibration without damage.

g. Holddown. The securing of an item to the base of a shipping container by applying lumber or metal over all or part of the item, and then tensioning, or otherwise locking down the lumber or metal in manner that prevents movement of the item within the container. One of the means of anchoring often used synonymously with tie down.

h. Humping. A method of making up trains in railroad yards by allowing individual cars to roll freely down an incline onto one of several tracks where the moving car is stopped, usually by collision with other cars already on the track.

i. Intermediate Pack. A wrap, box, or bundle which contains two or more unit packs of identical items, but is not necessarily the exterior container.

j. Marking. Application of numbers, letters, labels, tags, symbols or colors for handling or identification during shipment and storage.

k. Mechanical Damage. Damage resulting from any direct or indirect force which may impair the mechanical or operating function of the item. Some of the causes of physical and mechanical damage are illustrated in figure 1.

l. Military Packaging. The materials and methods or procedures prescribed in Federal/military specifications, standards, drawings or other au-

thorized documents, which are designed to provide the degree of packaging protection determined necessary to prevent damage and deterioration during worldwide distribution of materiel.

m. Packaging. The processes and procedures used to protect materiel from deterioration and/or damage. It includes cleaning, drying, preserving, packing, marking, and unitization.

n. Packing. Assembling of items into a unit, intermediate, or exterior pack with necessary blocking, bracing, cushioning, weatherproofing, reinforcement and marking (fig 3).

o. Physical Damage. Damage from internal or external forces which results in breakage, denting, marring, distortion, displacement, or abrasion.

p. Preservation. Application of protective measures, including cleaning, drying, preservative materials, barrier materials, cushioning, and containers when necessary.

q. Specification. A clear and accurate description of the technical requirements for a material, a product, or a service, including the procedure by which it can be determined that the requirements have been met. Specifications are often referenced in purchase orders, invitations for bids, supply manuals, and other procurement documents when the Government buys from industry.

r. Standard. A document that establishes engineering and technical limitations and applications for items, materials, processes, methods, designs and engineering practices.

s. Tiedown. The securing of an item to the base of a shipping container by attaching tensioning devices, such as strapping or wire, to or over the item. This is a form of anchoring.

t. Type of Load. The term "type of load" refers to the physical characteristics of the item, including the nature of the item as it contributes to the support of, or damage to, the container. The same kind of container can be designed to provide adequate protection to various items by adjusting the constructional requirements. This may result in a light-, medium-, or heavy-duty container, as necessary. The design of the shipping container to be used is influenced by the type of load. There are three types of loads: Type 1, Type 2 and Type 3. The types of loads will be mentioned under the various shipping containers and in section I (fig 4).

(1) *Type 1—easy load.* The load is a single item or single interior container which provides com-

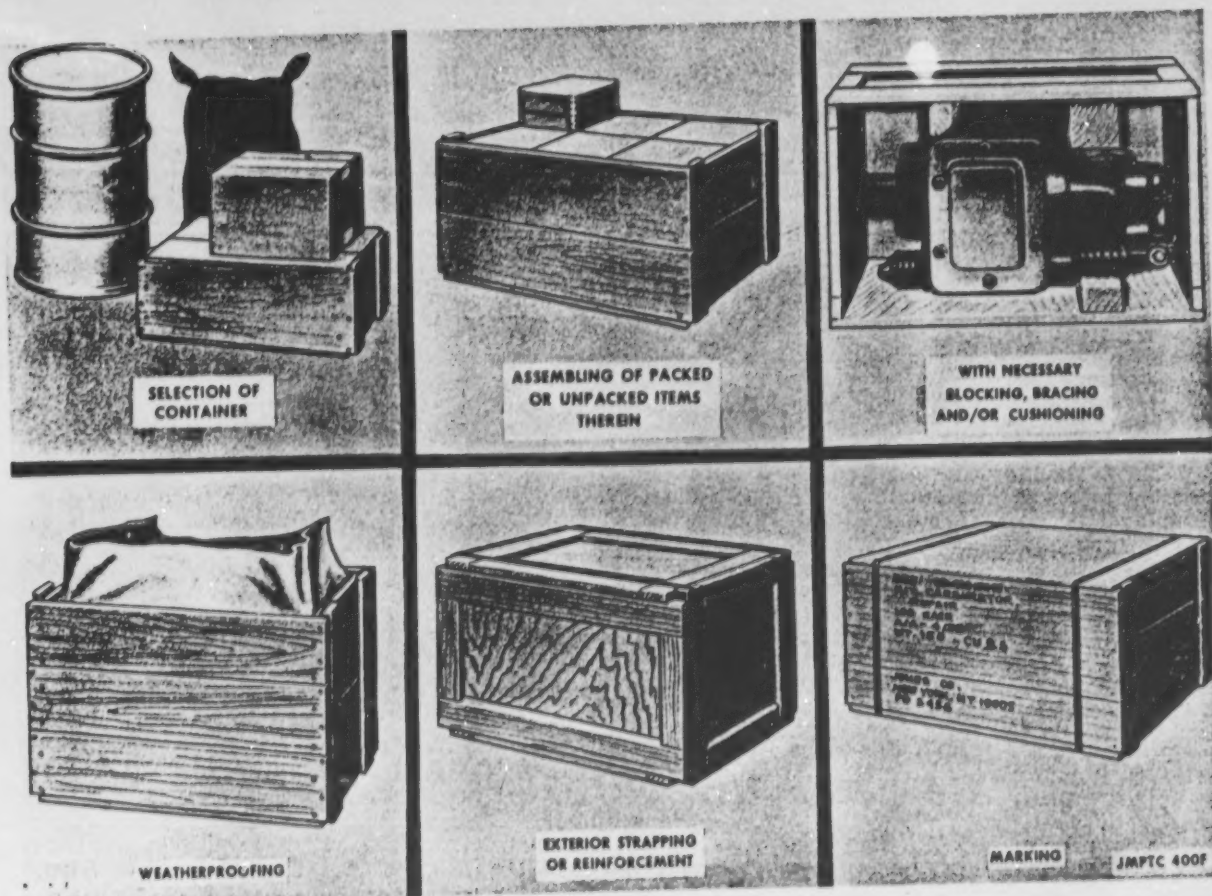


Figure 3. Operations involved in military packing.

plete and uniform support to all faces of the shipping container. The contents are of moderate density and relatively sturdy. Some examples are wood or metal chests, tool kits, and canned and boxed items packed in a fiberboard box which completely fills the shipping container.

(2) *Type 2—average load.* The load is composed of more than one item or interior container which give some support to all faces of the shipping container. The contents are of moderate density and relatively sturdy. Some examples are goods in metal cans which are not packed in an interior container, bottles individually cushioned, hardware in cartons, etc.

(3) *Type 3—difficult load.* The load gives little or no support to the shipping container. The contents can be extremely heavy, very fragile, very irregular in shape, bulk materials which are free to shift and flow, or a combination of several of these factors. Some examples are rivets, bolts and nuts, delicate instruments, machined parts and assemblies, etc.

u. Unit Pack. The first tie, wrap, or container applied to a single item or a quantity thereof, or to a group of items of a single stock number, preserved or unpreserved, which constitutes a complete or identifiable package.

v. Unitization. Assembly of packs of one or more line items of supply into a single load in such a manner that the load can be handled as a unit through the distribution system. Unitization (unitized loads/unit loads) encompasses consolidation in a container, placement on a pallet or load base, or securely binding together.

11. Economy in Packing

The military concept of economy in packing is to obtain maximum output of adequately protected items at a minimum cost. Economy measures, consistent with the degree of protection required by an item or package should be of prime concern to individuals engaged in the establishment of packing requirements, and to personnel in charge

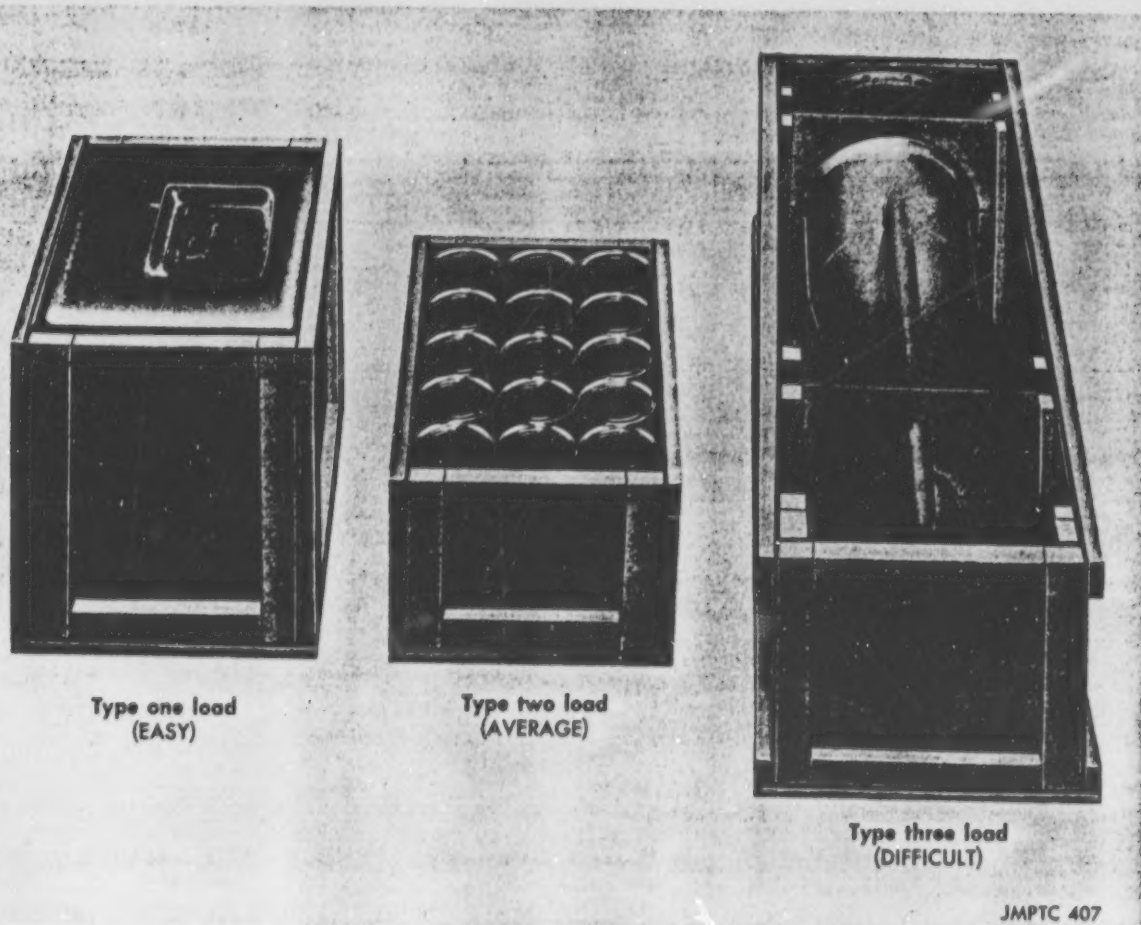


Figure 4. Types of loads.

of, or performing packing operations. Figure 5 illustrates the significant savings that were accomplished by reducing the tare weight, cubage, and packing cost of a commodity through proper reengineering of the unit and exterior containers, use of newly developed materials, and employment of alternate methods and techniques.

12. References

Throughout this manual, packing materials, equipment, processes, methods, etc., are referred to by their common names together with the appropriate specification, standard, or other publication symbols. Copies of specifications and other documents required by activities of the Defense Logistics Agency, the Department of the Army, Navy, and Air Force, and the Marine Corps are

obtained from supply sources through established channels. Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Military and Federal Specifications plus Standard are available from: Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120, and information pamphlet titled "A Guide for the Private Industry" provides more detailed information and is available upon request.

13. National Stock Numbers

General information concerning National stock numbers and their use in the Military Logistics System is found in the appendix.

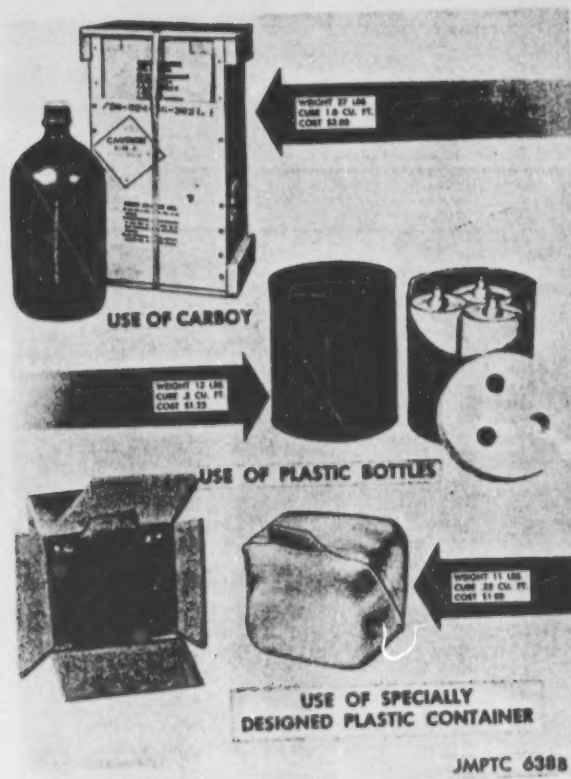


Figure 5. Savings through redesign of packs.

CHAPTER 1

PACKING

1-1. General

a. Packing of General Supplies. Some commodity items require preservation by procedures and materials described in TM 38-230, Volume I, which provide unit containers suitable for shipment without further packing. Other items may require further packing in containers suitable for shipment. This chapter relates to the packing of commodity items directly in shipping containers with whatever protection is required to prevent damage in shipment, handling and storage. The container alone cannot always provide full protection for military items. Items must be properly anchored, braced, blocked, or cushioned in the container to provide adequate protection. A container is often blamed for damage to its contents when the cushioning, blocking, or bracing are at fault (fig 1-1). Every packing operation, including the final closure, strapping, and marking of the container, must be carefully planned and executed to ensure that the contents will arrive at destination in a usable condition.

b. Packing of Hazardous Articles. Commodities classified as hazardous materials come within the scope of the Code of Federal Regulations, which incorporates Department of Transportation Regulations for the Transportation of Explosives and Other Hazardous Articles by Land and Water in Rail Freight Service and by Motor Vehicle (Highway) and Water; the Federal Aviation Administration regulations relative to the transportation of dangerous articles and magnetized materials; and the United States Coast Guard hazardous cargo regulations. In addition, dangerous materials which are to be shipped via military aircraft must be packed in accordance with the joint services manual AFR 71-4, TM 38-250, NAVSUP Pub 505, MCO P-4030.19, DLAM 4145.3.

1-2. Sequence of Packing Operations

The general sequence of military packing is divided into a series of basic operations which may include some or all of the following steps, not necessarily in the order given below:

a. Determine the Packing Requirements. Study the item characteristics (para 1-4) to determine the protection required and the best way to provide it through the use of an adequate container, suitable blocks, braces, and cushions, and appropriate barrier materials. This study will include consideration of the characteristics of the item, its size, shape, fragility, etc.; the types of loads (easy, average or difficult); the mode of transportation (rail, ship, truck, or aircraft); the storage facilities (covered or uncovered); the destination (domestic or overseas in the arctic, temperate, or tropic zones); and the levels of protection required (See Introduction para 7).

b. Select the Container. Select and use an exterior container that will comply with the requirements outlined in applicable chapters of this manual. This selection should consider all factors pertinent to giving adequate protection at a minimum cost such as the characteristics and limitations of the container; its initial cost and upkeep expenses; its weight and cube; its availability or obtainability in appropriate quantities; and its reusability.

c. Prepare Protective Barriers. Prepare an appropriate barrier to give weatherproofing protection not obtainable from the container alone.

d. Insert and Secure the Item to the Container. Insert the item and secure it to the container to control or prevent movement by means of adequate cushioning, blocking, and bracing. The distinction between cushioning and blocking and bracing is that cushioning permits controlled movement of the item within the container, while blocking and bracing usually is designed to prevent movement of the item within the container.

e. Seal the Barrier, if Used. Seal the barrier material by means of adhesives, heat seals, pressure seals, or sealing tape to provide weatherproofness of the seams, joints, and closures equal to that of the barrier material itself.

f. Close the Container. Close the container following the detailed requirements outlined in the

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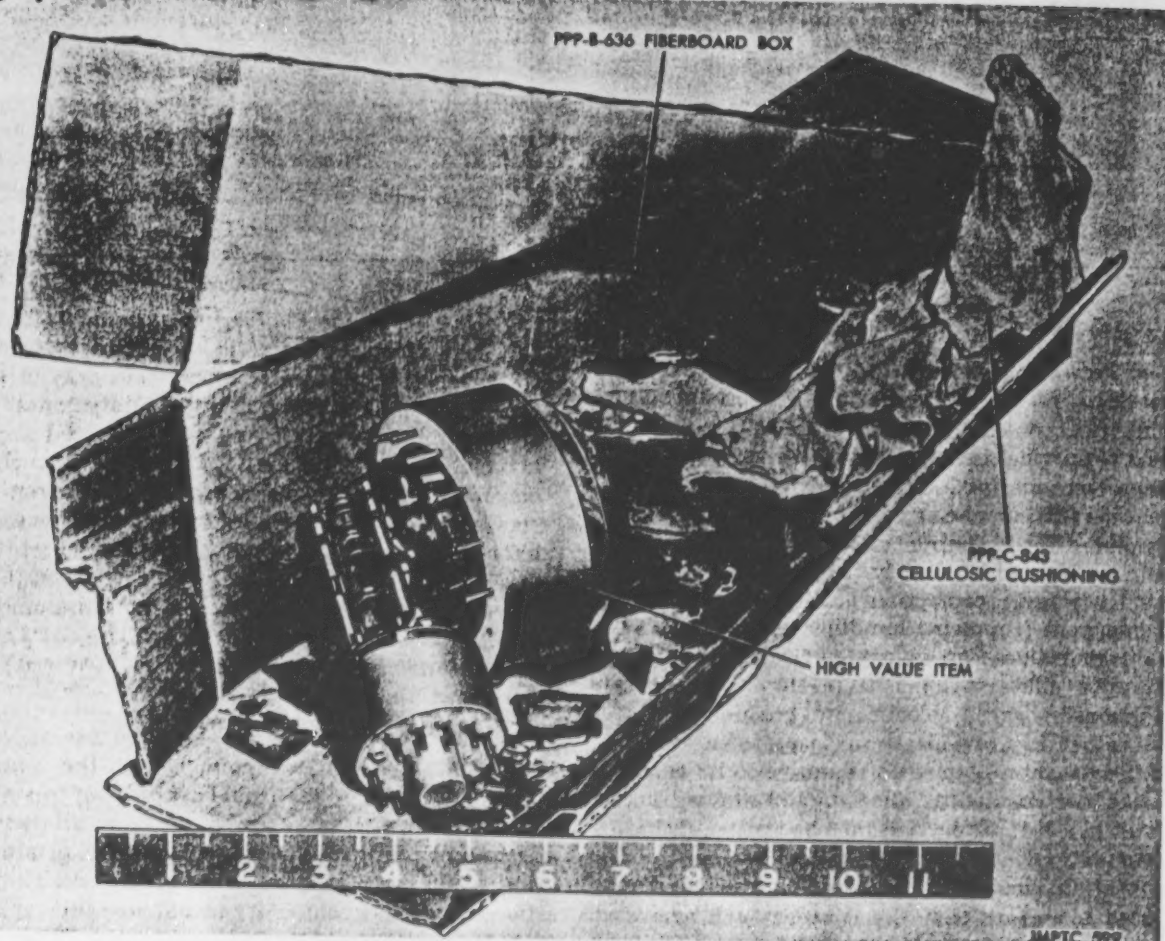


Figure 1-1. Damaged item as a result of improper/inadequate packing.

section of this manual which describes the container selected.

g. Reinforce the Container. Reinforce the container with metal strapping or reinforced tape as appropriate or as required for the container selected.

h. Mark the Shipping Container. Mark the container as appropriate to identify the contents and to ensure movement to its destination.

1-3. Determination of Packing Requirements

The different types of items procured by the Department of Defense require a wide variety of packing operations. Items vary from strong, rugged ones that fit the container well and require no cushioning or blocking, to others that are irregular in shape, delicate, or fragile, and require special cushioning and blocking.

a. Basic Factors. To determine packing requirements, several basic factors must be considered, namely, the item characteristics, the load characteristics, the mode of transportation, the storage and handling facilities, and the destination and field conditions.

b. Basic Reference. The basic reference for blocking, bracing, and cushioning is Military Standard 1186, "Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; with Appropriate Test Methods." This standard, approved by the Department of Defense and mandatory for use by the Armed Forces, provides general requirements and procedures concerning the arrangement of the contents within the shipping container for the prevention of physical damage.

c. Scope of MIL-STD-1186. This standard covers common packing requirements which may be

omitted from detail specifications for items or categories of items when this standard is referenced in the detail specification. It does not contain requirements for shipping containers themselves or for unit packing both of which also provide physical protection. Tests for determining the adequacy of the protective measures to prevent damage to the package contents or package materials (barriers) are described in paragraph 1-24.

1-4. Item Characteristics

The first step in any packing operation is a careful study of the item to be packed. It is necessary to consider the shape, size, weight, strength, and degree of fragility of the item in all directions. The availability of mounting provisions, the degree of disassembly permissible for shipment, corrosion prevention requirements, and special use requirements which affect the packing operations must be considered.

a. Shape. The shape of the item to be packed is an important factor to consider in designing blocking and bracing. A regular-shaped item with rectangular surfaces requires a minimum of blocking, while an irregular-shaped item with uneven surfaces, including projections, often requires an elaborate blocking system. Curved surfaces require carefully fitted blocking to prevent damage caused by concentrated stresses at contact points, and to distribute internal forces over a greater area of the faces of the container (fig 1-2). Long, slender items, particularly if heavy, exert a tremendous concentrated force on the ends of the container during handling. This force may be counteracted by securely blocking the item to the

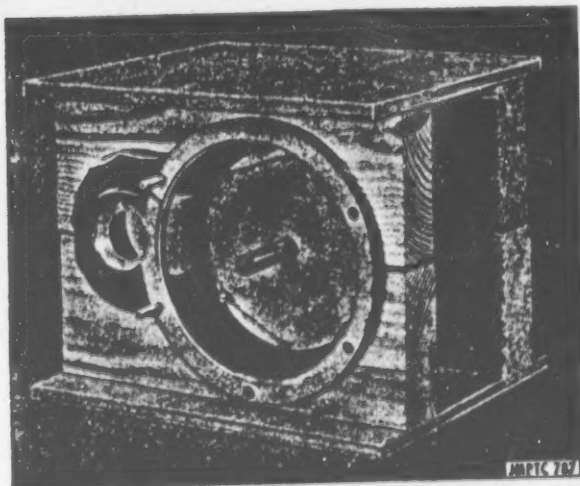


Figure 1-2. Interior blocking for an irregular-shaped item.

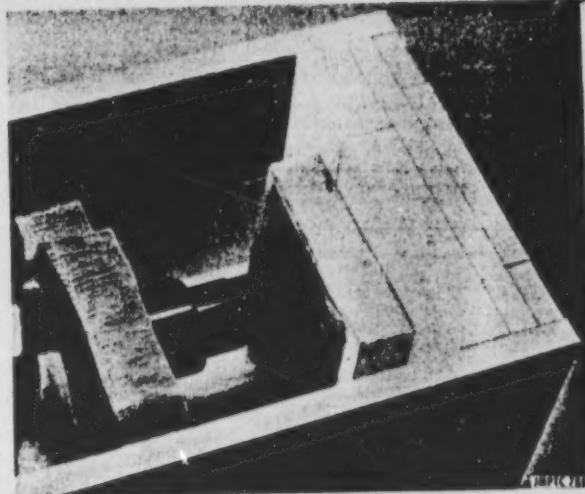


Figure 1-3. Interior blocking to protect container against end thrust.

sides, top, or bottom of the container, and by increasing the thickness of the ends of the container (fig 1-3). Relatively heavy, irregular-shaped small items present a particularly difficult problem when they must be cushioned as well as blocked. Generally, in solving this problem, it is desirable to even out the surfaces by means of pads and blocking to increase the bearing area. This in turn decreases the load per unit area of bearing on the cushion (fig 1-4).

b. Size and Weight. A large item may require more extensive blocking and larger amounts of cushioning than a smaller one. The blocking may be necessary to bridge the relatively wide spans of the container faces, or it may be required to distribute the cushioning over larger areas of the item. Since the impact force developed by the abrupt stopping of a moving object is directly proportional to its weight, the weight of an item is very important in considering the blocking and cushioning. In studying the item, consider the distribution of the weight with respect to the size and bearing areas. Where the weight is concentrated, it may be necessary to distribute it over a larger area. This may be done by transferring some of it from one container face to the edges or corners of the container by the use of end blocks.

c. Strength and Fragility. Some items are rugged enough to withstand greater stacking loads and handling forces than their containers. Various components of vehicles and tanks, in particular, require little protection against shipping hazards, but are placed in containers for ease of handling, stowage, and storage. On the other hand, there are numerous items that require the

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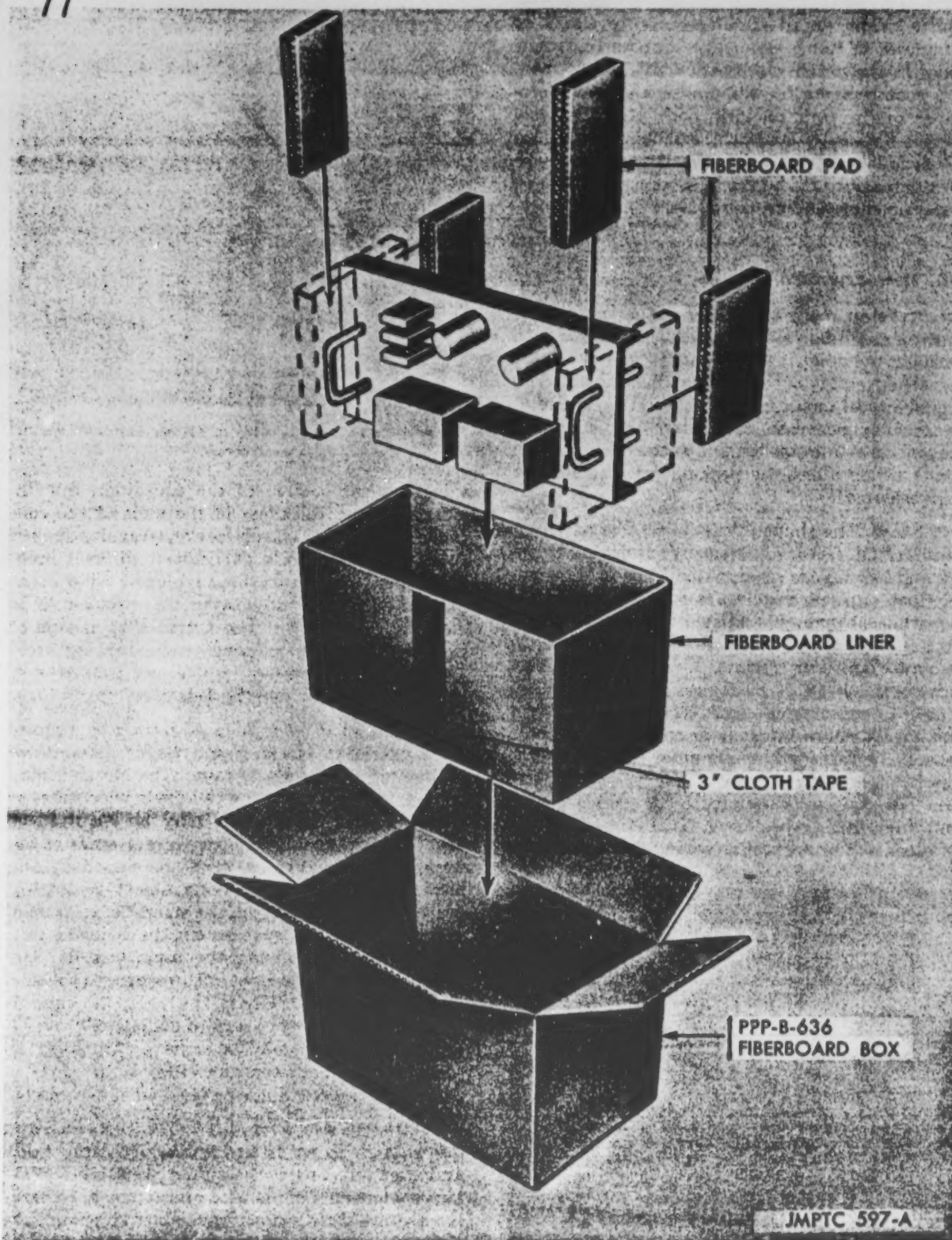


Figure 1-4. Use of corrugated fiberboard pads and liner.

maximum protection afforded by packing materials. Equipment is considered rugged or highly resistant to shock when bracing and blocking within the container is all that is needed for protection. Items that require cushioning for protection are considered to be fragile. The degree of fragility of an item determines the amount of cushioning required to protect it from damage during handling and shipment. Some items are inherently strong and rugged except for one or more fragile components. When the fragile components cannot be removed for separate packing (fig 1-5) then the entire item must be treated as fragile, even though this may result in an unavoidably large, cumbersome pack.

d. Availability of Mounting Provisions. An important factor to consider in packing is the availability of brackets and holddowns on the item that can be used to mount it within the container. Frequently, it is possible to mount an item within the container by using the same brackets and holddowns that are used for positioning and securing it in place when it is permanently installed. Mounting facilities should be examined to determine if they are adequate, especially if the container is likely to be tipped on end (fig 1-6). Compressors, engines, engine components, generators, starters, magnetos, and carburetors are often secured in this manner.

e. Disassembly. Disassembling of an item to reduce the size of the container and to simplify preservation and packing of the various components should be thoroughly investigated (fig 1-7). Before disassembling any equipment, however, competent advice should be obtained as to the feasibility of reassembly and calibration, if necessary, in the field.

CAUTION

Proper authorization must be obtained before disassembling any portion of an item that would require technical skills or special tools to reassemble, realign or recalibrate. Disassembly of simple-to-remove components such as handles, wheels, etc., requiring standard tools, does not need authorization.

f. Special Packing Requirements. Reusable and other special purpose containers usually require special consideration of the packing of the contents in the container. For instance, in reusable containers, the blocking and cushioning must be arranged so that it may be easily removed, and when replaced, it will adequately protect the contents. However, reusable and special purpose containers should be considered for use, especially if their use



Figure 1-5. Removing a fragile component for separate packing from an otherwise strong and rugged item.

results in reduced tare, cube, or cost. For example, the reusable container for a missile nose cone, shown in figure 1-8, while expensive to procure, may more than pay for itself through its reusability and its designed protection features.

1-5. Load Characteristics

The proper selection of the shipping container for a given load is of the utmost importance. The kind of container must be determined by the weight, size, shape, and fragility of the load. To aid in this selection, the various loads have been classified as Type 1—Easy Load, Type 2—Average Load, and Type 3—Difficult Load. (See Introduction, para 10t and fig 4.)

1-6. Modes of Transportation

The mode of transportation is an important factor in determining the packing requirements. The

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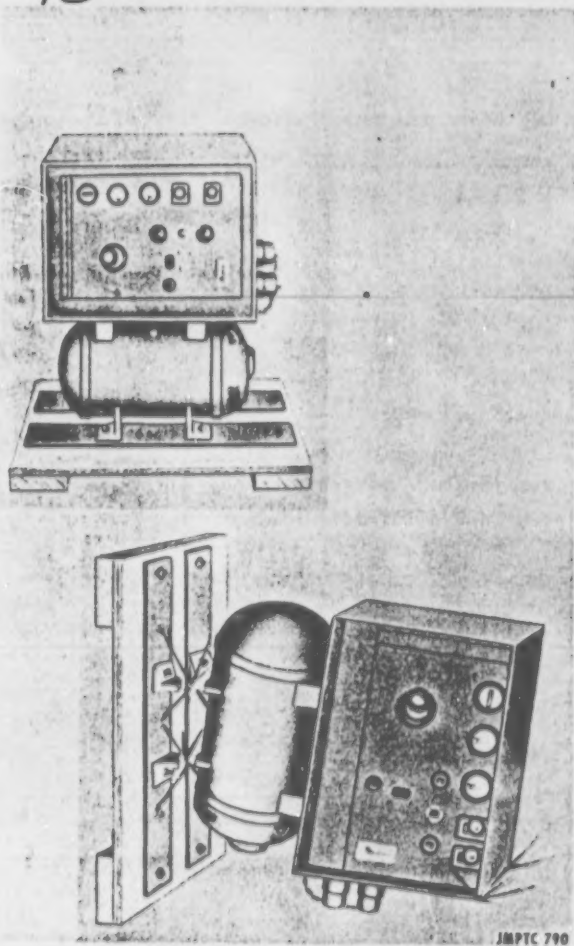


Figure 1-6. Mounting facilities of item must be adequate.

hazards of handling and shipping vary greatly between motor, rail, ship, or aircraft. As an example, there could be considerable difference in the amount of handling that an item being transshipped from truck to rail to ship would receive, and the amount of handling an item delivered by air freight would receive. Likewise, an item to be delivered by airdrop would require much more protection than one to be delivered by truck.

1-7. Storage Considerations

To assure serviceability of the contents after prolonged exposure to deteriorating elements, not only the supplies, but the packing materials which enclose them must be protected. There may be a considerable period from the time the material leaves the manufacturer until it is used. It may be stored outdoors in domestic depots, then shipped to staging areas or ports of embarkation to await

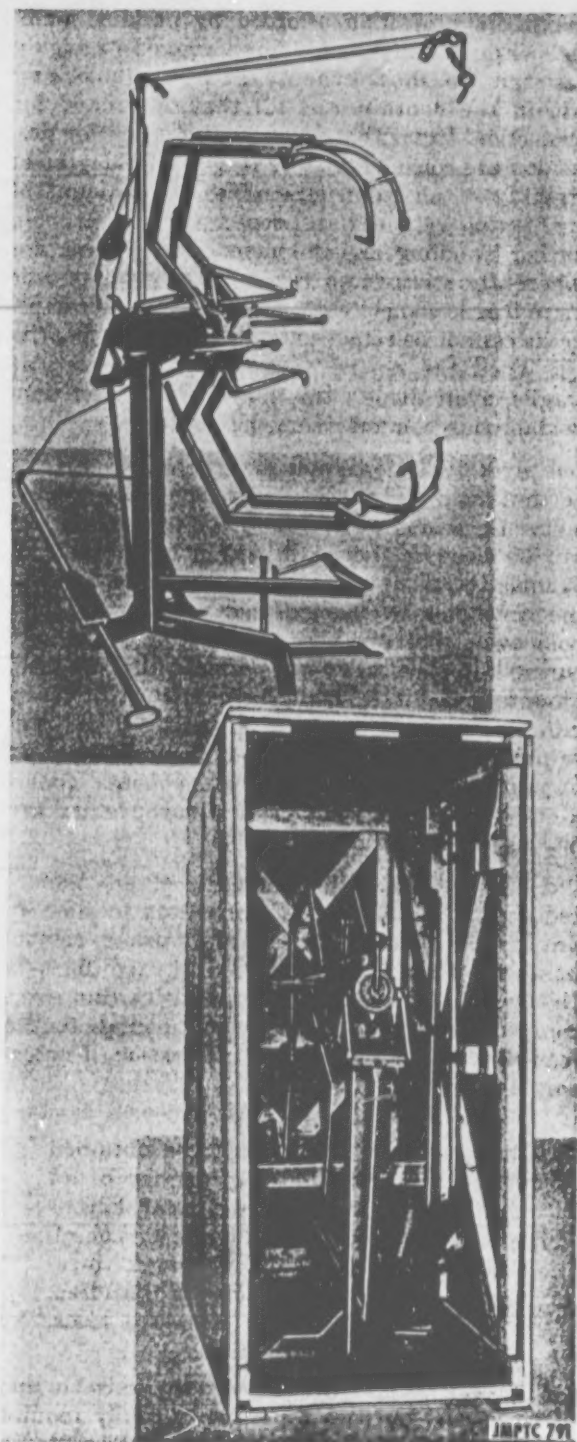
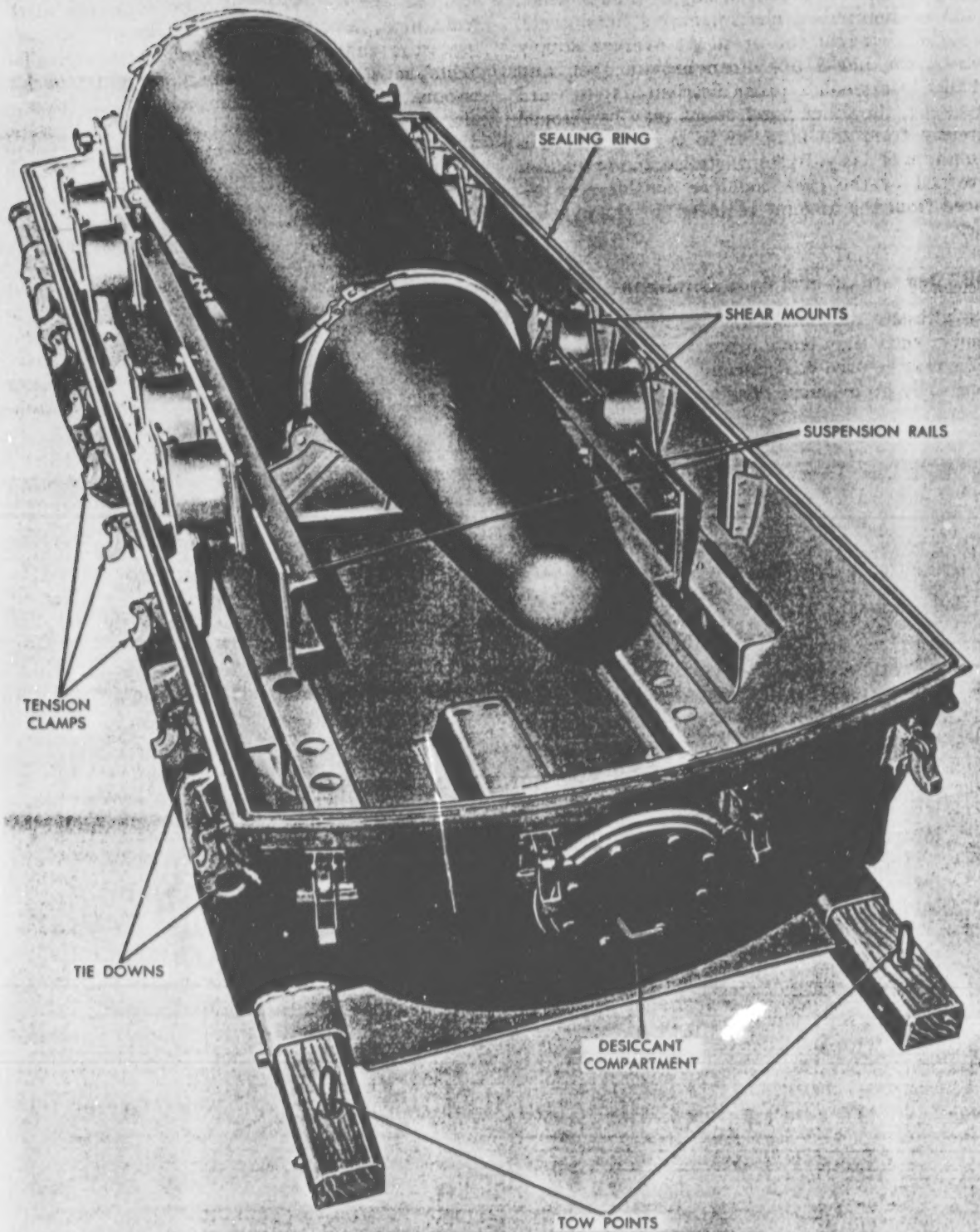


Figure 1-7. Disassembly can reduce cube.

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Figure 1-8. Protection features of a reusable missile container.

transportation overseas. Finally arriving, it may again be stored in depots or supply dumps which could be improvised shacks, native huts, tents, caves, or even in the open. At overseas supply points, the packs are often broken open and smaller intermediate packs distributed to forward areas. On the other hand, items may be shipped directly from the supplier to the user with a minimum of delay. In this instance, the protection provided by the pack could be considerably reduced from the amount required for the oversea pack.

1-8. Destination and Field Conditions

The ultimate destination of items is generally unknown when they leave a packing facility. Some items may be used domestically while the rest will eventually go overseas. They may be shipped to

the arctic regions, the islands of the seas, or the tropical jungles. They may be subjected to the cold, heat, humidity, aridity, or the extreme temperature changes of the various regions, all of which must be considered in planning the pack to assure adequate protection through the time of delivery and after arrival at destination when they may be subjected to unfavorable field conditions.

1-9. Functions and Selection of Shipping Containers

a. Functions. A shipping container is any exterior box, crate, drum, etc., which is required to enclose one or more items during transit or storage. Where only one item is packed, the shipping container is also considered the unit container. The basic functions of a shipping container are to

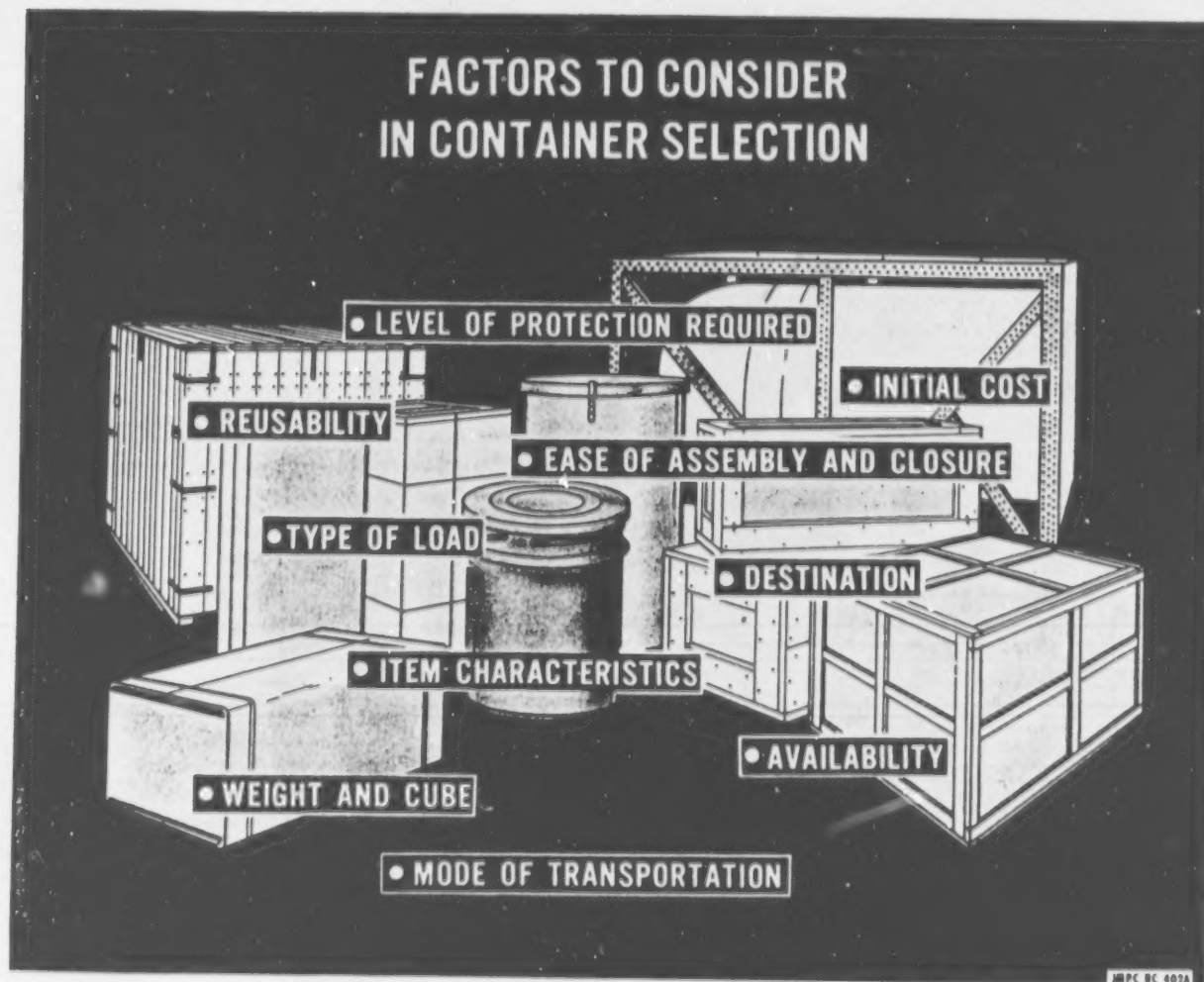


Figure 1-9. Container selection factors.

protect the contents and to provide for ease of handling. Shipping containers assist in the handling of a number of items by consolidation, and of a single item which is difficult to handle. The degree of protection derived from the shipping container depends upon its type, the materials used in its fabrication, its construction features, its final destination, the nature of the contents, and the anticipated hazards. Chapters 2 through 7 of this manual contain information on approved containers for military shipments and should be consulted when making selection of the appropriate containers.

b. Selection. The shipping container is usually established by specifications, directives, technical orders, or other authorized publications. Where a group of containers is authorized, or when the proper container is not specified, the packing supervisor is responsible for the selection of the appropriate container. He must base his selection upon the physical characteristics of the item, its destination, whether domestic or overseas; the level of protection required; the type of load, the initial cost of the container; the weight and cube of the container; the simplicity, economy and ease of assembly and closure; the availability; and the need for reusability of the container (fig 1-9). Nailed wood boxes or similar heavy wooden containers will not be used unless fully justified by past experience or environmental, geographical, or security considerations.

1-10. Arrangement of Contents

The contents of a pack should be arranged within the shipping container so as to provide maximum protection to the interior packing, to the container, and to its contents. Where applicable, the arrangement should permit a container fabricated of materials that will result in low tare weight, smallest practical cube, convenient handling, and suitability for palletization. Contents should completely fill the container or be secured therein with suitable clearance. Packs of like items should contain like quantities and should be uniform in size, shape, and weight.

a. Disassembled Parts. When practicable, items should be disassembled to afford protection of components, attachments, and accessories against damage and pilferage and to reduce cubage. Disassembled parts should be wrapped, packaged, anchored, braced, blocked, or cushioned within the shipping container so that parts or protective devices within the shipping container cannot be damaged by mutual contact. Disassembled parts should be clearly and legibly marked as to identity

and proper location on the assembled item. All fasteners removed during disassembly should be secured in one of the mating parts. A part should not be removed from an assembly unless it can be reassembled readily in the field without special tools.

b. Movable Parts and Projecting Parts. Articles with moving external parts or projecting parts that might become damaged by shock or vibration encountered in shipment should have these parts made secure against movement by means of blocking, bracing, tiedown, or other adequate provisions; or should be disassembled, if practicable.

c. Segregation of Packed Contents. So far as practicable, contents of shipping containers should be segregated in the following order: (a) the order on the packing list; (b) items of the same contract; (c) items of the same National Stock Numbers; and (d) items of the same Federal Supply Class.

d. Conversion of Type 3 Loads. Where practicable, type 3 loads should be converted to type 1 or type 2 loads. (See Introduction, para 10c.)

1-11. Blocking and Bracing

a. Blocking and Bracing Defined. Blocking and bracing is the process of providing physical and mechanical protection to an item by means of materials, other than cushioning materials, intended to prevent any free movement of the item within the container, and distribute or transfer concentrated loads of the item to larger areas or other faces of the container.

b. Functions of Blocking and Bracing. Items which do not completely fill the shipping container should be blocked, braced, anchored, or otherwise immobilized within the container. Blocking and bracing should be used to secure items or components so that they will not shift within a container; to make irregular shaped items fit a regular container; to distribute the weight of irregular items over all edges and faces of the container; to protect projections from injury; to prevent projections from damaging the barrier or container; to provide space for spare parts or make room for desiccant; and to reinforce weak portions or mountings. Blocking and bracing modifies the original shape of an item so that it is protected adequately and so that it fits the container. The materials used for this purpose differ from cushioning in that they are not intended to absorb shocks. Items having legs or other projecting portions which may become loose or broken, or which might puncture the container, must be

supported by adequate blocking and bracing. The blocks and braces should be applied against portions of the container that are strong enough to resist forces tending to distort them. Likewise, the bracing should be arranged to distribute forces to several reinforced sections of the surface of the item (fig 1-10). Items or movable parts of items mounted on springs or other flexible supports should be braced securely to prevent movement, except where such mounting is part of the package cushioning or is designed to protect against shock and vibration during shipment.

c. Abrasion Protection. Protection should be provided when the surface of the item in contact with the blocking and bracing can be damaged by relative motion between the contacting surfaces or could become corroded as a result of such continuous contact. Protection against abrasion should be provided for highly finished or easily marred surfaces by wrapping or covering with cushioning material. Surfaces that might be damaged by contact with cushioning material should be separated by a covering of noncorrosive paper conforming to MIL-P-130 or greaseproof barrier material conforming to MIL-B-121, grade A. For specialty items requiring protection beyond the above, kraft paper with a cohesive coating should be applied.

1-12. Application of Blocking and Bracing Materials

The materials selected for all blocking and bracing and the design and application of the blocking and

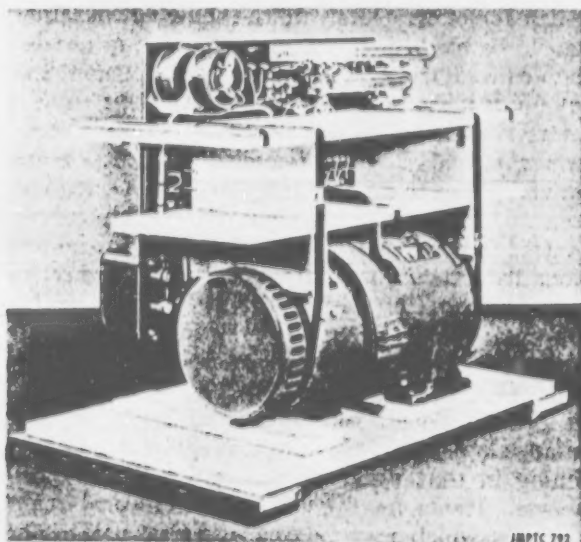
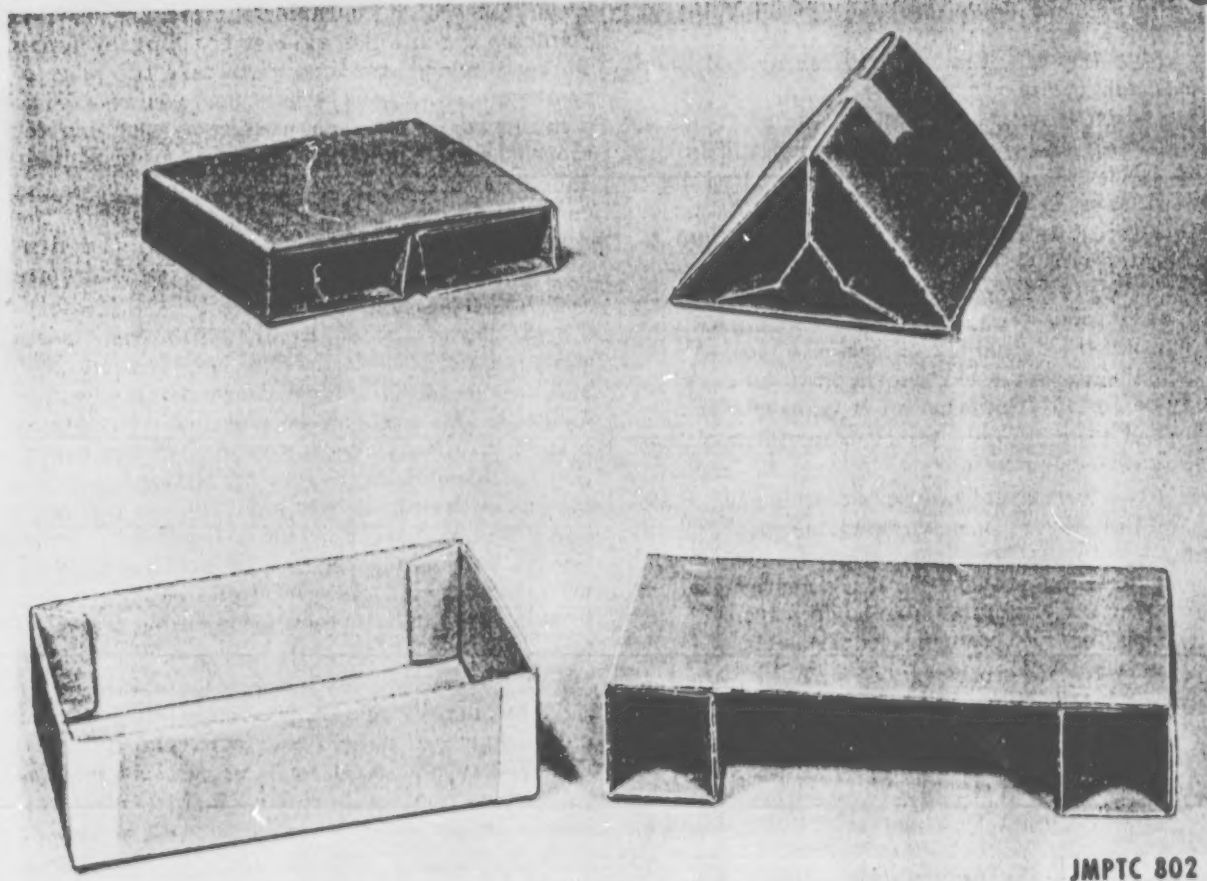


Figure 1-10. Blocking and bracing to prevent movement.

bracing should be compatible with the load to be supported and the size, shape, and strength of bearing areas of the item. The heavier the load needing support, the stiffer and stronger the materials for blocks and braces must be. Hence, the choice of materials depends upon the size and shape of the areas against which the blocking and bracing will be placed, as well as the size and weight of the item being secured. Since a shipping container may be dropped on any of its faces or corners, blocks and braces must be designed to withstand the thrust and impact applied on any direction. The choice of materials used for blocking and bracing vary widely. The chief materials used are corrugated fiberboard in cells, trays, pleated pads, and flat pads, for relatively lightweight items or for supplementary primary blocking of heavy items. Wood, plywood, rigid plastic foams, and metal are used as the primary blocking materials for large and heavy items.

a. Fiberboard.

(1) *Open-end cells and trays of corrugated fiberboard.* When used as blocking, corrugated fiberboard must be designed to fit the bearing area of the item to support and evenly distribute the load. Common forms of corrugated fiberboard blocking are die-cuts, open end cells, trays, pleated pads, and flat pads (fig 1-11 and 1-31). Frequently, various combinations of these forms are employed. They can be used to provide spaces for, and restrain the movement of, disassembled parts, as well as provide openings for bags of desiccant. Generally, cells and trays should be held in shape with tape or staples. Those surfaces of the cell or tray which are perpendicular to the contacting surface of the item are called bracing supports and are the load bearing members. No bracing support allowances should be made for the other surfaces. To utilize all of the strength of these bracing supports, they should bear directly on the item. The weight of the item must be exerted in the same direction as the corrugations. If not, the item is inadequately supported and damage may result (fig 1-12). Open-end cells and trays should be used for blocking and bracing deep recesses; bridging long projections; providing spaces for disassembled parts, accessories, and desiccants; and providing clearance between item and container. Bracing supports should bear directly on the article. Allowable loads for bracing supports of open-end cells loaded in the flute direction should be in accordance with table 1-1. If flute direction is at right angles to the direction of the load, the allowable loads should be 50 percent of the values of table 1-1. Trays should be scored



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Figure 1-11. Colla and trays made of corrugated fiberboard.

and folded parallel to the flute direction and should not exceed 4 inches in height.

(2) *Corrugated fiberboard forms.* Corrugated fiberboard used for blocking and bracing should conform to Specification PPP-F-320. Blocking and bracing forms should be loaded in the direction parallel to the flutes wherever possible. The cutting, slotting, scoring, and folding of fiberboard blanks to make blocking and bracing supports or forms shall be such as to assure proper fitting and distribution.

(3) *Folded pads.* Folded pads of corrugated fiberboard may be used for blocking greater loads than are feasible to support with cells and trays. The pads should be designed to fit against a flat surface (flat pads) or along an edge (corner pads). Connecting webs between flat pads should always contact the container and not the item. All scores and folds should be made at right angles to the flute direction. Flat pads should be a minimum of 2 inches wide. Portions of folded pads in direct contact with the item are bearing areas. The

maximum loads for these bearing areas should be in accordance with table 1-2. Accordion folded pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than on bracing supports. Accordion folded pads with tight folds distribute the load more evenly to the container. The connecting web between the folded pleats should be placed in contact with the container rather than the item. Creases for accordion folded pads should be made across the corrugations, and the pleat should be at least 2 inches in width. If necessary, a pleat 1½ inches wide may be made, but extreme care must be exercised when folding the pad to prevent crushing the corrugations. Tape should be used to keep accordion folded pads in shape. The load bearing capacity of a pad is based on the initial compressibility of the corrugated material. Increasing the number of pleats does not increase the safe load limit; numerous pleats increase the cushioning value only. Wide or long items are better supported by several accordion folded pads,

placed side by side, than by one pad having extremely wide folded pleats.

(4) *Flat pads.* Flat pads of corrugated fiberboard may be used to block very shallow projections, such as hinges or slight offsets on surfaces; to level off projecting screw heads; to fill in the space between ends of inner flaps of slotted fiberboard boxes to provide additional protection to contents at top and bottom of boxes; and to separate items within a container. Allowing loads should be in accordance with table 1-2. Maximum allowable loads per square inch of bearing area on a flat pad are the same as those for a pleated pad. Flat pads can be slotted to form partitions, or they may be die-cut or punched to fit items of irregular shape. Figure 1-13 shows the assembling of slotted fiberboard partitions.

(5) *Corner pads.* The use of corner pads made of multiple layers of corrugated fiberboard shall comply with the load requirements of table 1-2. The pads shall provide required clearances and support for rectangular shaped items or for an inner box in which items are packed.

(6) *Tubes.* Fiberboard tubes should be used as blocking when items mounted on an auxiliary base are packed on fiberboard boxes. The bottom of the tube shall contact the top of the auxiliary base and the top of the tube shall contact the top inside surface of the container. The flutes shall be oriented in the top-to-bottom direction of the tube. The weight of the item plus auxiliary base, in pounds, divided by the perimeter of the tube, in inches, shall not exceed the appropriate values given in table 1-2 for column heights over 4 inches.

(7) *Corrugated fiberboard liners.* A liner is a continuous pad, bent to fully contact two or more

inner faces of a container. Liners are used to reinforce a container against crushing by forces imposed during stacking, or to take the place of two or more flat pads. A liner may also be used as a hold-down for base mounted items weighing not more than 20 pounds. The creases in a liner should be made parallel to the direction of the corrugations of the fiberboard, in order that the resistance to forces ordinarily encountered in stacking be the greatest. Examples of liners are shown in figure 2-11.

(8) *Corner posts.* Fiberboard corner posts should be used to reinforce the shipping container and provide blocking for platform-mounted equipment. The flutes should be oriented in the top-to-bottom direction. The bottom end of the corner post shall bear uniformly on the platform, and the top end of the corner post shall bear on the inner flap of the container or top member of a crate. Corner posts, when installed, must so interlock with the contents and other inner padding pieces in order not to become displaced during transportation.

(9) *Other rigid, low-density materials.* Other rigid, low-density materials, such as molded wood pulp, industrial cane fiberboard conforming to PPP-F-320, and rigid foam or cellular plastics conforming to MIL-P-19644, or MIL-P-21929, cut, foamed in place, molded, or otherwise formed as required, may be used for appropriate blocking and bracing applications.

b. Wood or Plywood. Wood or plywood may be used alone or in combination for blocking and bracing. Wood or plywood blocking and bracing members should bear against only those parts of the packed item capable of withstanding the applied dynamic forces or should bear against blocking pads or pressure strips that adequately distribute these forces. Wood or plywood blocking and bracing should be designed to permit easy removal without damage to the item. Both wood and plywood are used for blocking and bracing

Table 1-1. Allowable Loads for Corrugated Fiberboard Columns Loaded in the Flute Direction

Material	Allowable loads per lineal inch of bracing support or column	
	Height up to 4 inches	Height over 4 inches
	Pounds	Pounds
Double-faced fiberboard:		
200-pound bursting strength	2	1
275-pound bursting strength	2.5	1.5
350-pound bursting strength	3	2
Double-wall fiberboard:		
275-pound bursting strength	2.5	1.5
350-pound bursting strength	3	2
500-pound bursting strength	4	2.5
Triple-wall fiberboard:		
1,100-pound bursting strength	5	4

Note. When a greater load is imposed than that permitted by the table, use wood blocking and bracing.

Table 1-2. Allowable Loads for Folded Corner and Flat Pads of Corrugated Fiberboard

Flute design	Maximum allowable load for bearing areas
	Pounds per square inch
A-flute (36 ± 3 corrugations per foot)	2.0
B-flute (50 ± 3 corrugations per foot)	3.0
C-flute (42 ± 3 corrugations per foot)	2.5

Note. The flat crush resistance of the corrugations shall determine the load that may be carried in flat loading of corrugated fiberboard. This shall not be construed to mean the bursting strength of the material.

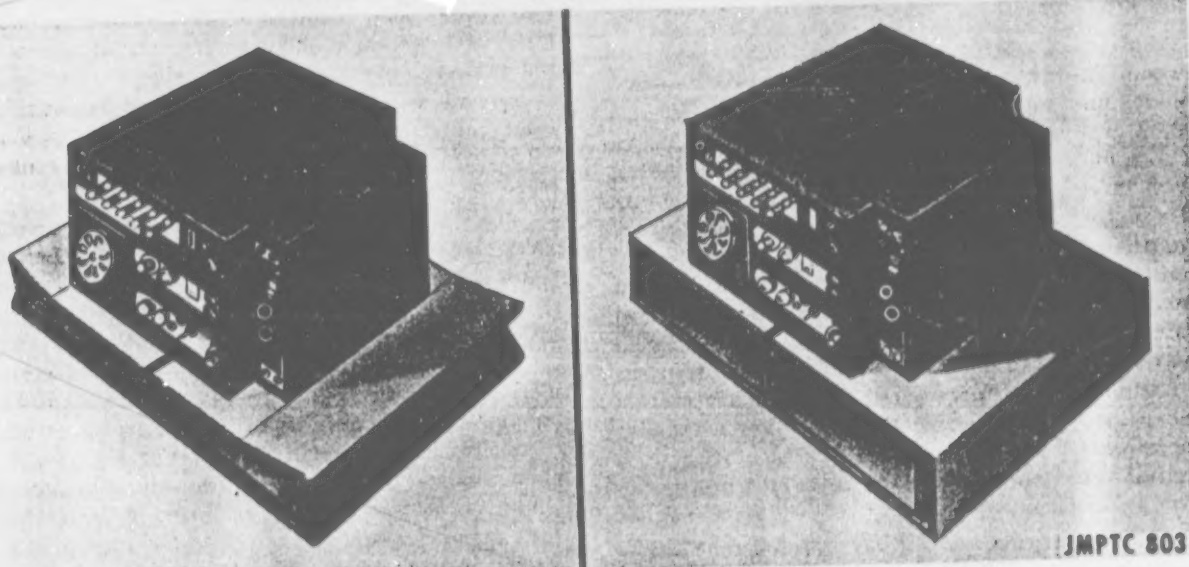


Figure 1-12. Incorrect and correct direction of corrugations.

because of their high strength-weight ratio, general availability, and ease of cutting and fastening. Lumber has certain weaknesses, such as low splitting resistance parallel with the grain, and a tendency to shrink or swell with each change in moisture content. Conversely, plywood has high resistance to splitting and high dimensional stability with changes in moisture content. Because they are more resistant to splitting than solid wood, plywood panels are more often used in thinner dimensions than lumber, and are readily nailed or fastened with screws near the edges. Plywood is more apt to have a lower moisture content than lumber because of the manner in which it is manufactured and stored. Plywood, being constructed of alternate plies at right angles to each other, possess more uniformly distributed strength properties than lumber. When considering lumber and plywood of comparable sizes and quality, it is generally true that the strength properties of lumber parallel to the grain are greater than the respective strength properties of plywood parallel to the grain of the face ply. It is also true that the strength properties of lumber perpendicular to the grain are generally less than the respective strength properties of plywood perpendicular to the grain of the face ply.

(1) **Wood.** Wood used for blocking and bracing should conform to MIL-STD-731. One wood member of each size and type used in the blocking and bracing should be tested for moisture content. Structural members (those subject to critical bending stresses) shall conform to class 1. All

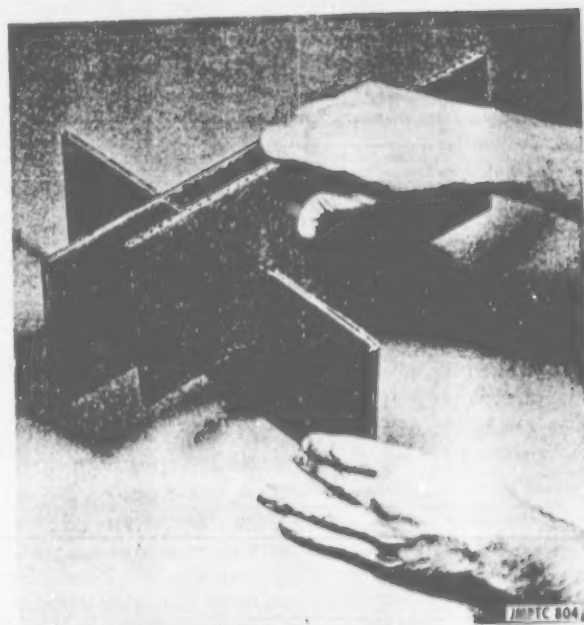


Figure 1-13. Assembling of slotted fiberboard partitions.

other blocking and bracing members shall conform to class 3. Whenever possible, wood blocks or braces shall be placed so that the load is applied against the end grain of the member. Ends of braces shall be socketed or fitted and secured into appropriate notches in load-bearing members.

(2) **Plywood.** Plywood used for blocking and bracing should conform to Specification NN-P-

530, group as specified in the item procurement document.

c. *Wood Blocking and Bracing.* The species of woods differ greatly in strength and related properties and, accordingly, have been separated into four groups (para 3-1). Certain species, such as those of Group IV, excel in toughness and shock resistance, but care must be exercised in nailing them to avoid splitting. Other species, such as southern yellow pine and Douglas fir of Group II, are high in bending strength and stiffness; and nailing is a lesser problem. The characteristics of the groups of wood may be used to advantage in various forms of blocking and bracing. Thin pieces of lumber split more easily than thick pieces; hence, thin pieces for blocking should be avoided if possible. If the dimensional limits of the item require that the blocking be thin, it is preferable to use plywood.

(1) *Moisture content.* In accordance with MIL-P-116, the moisture content of lumber employed as blocking and bracing material should not exceed 19 percent nor be less than 7 percent of its oven dry weight at the time of fabrication. Shrinkage is objectionable because it allows movement of the item, and the item may actually break loose. Moisture in lumber is objectionable because it is apt to evaporate into the pack, thus raising the humidity of the pack and causing corrosion of metals or decay of organic materials (para 3-1).

CAUTION

Lumber, plywood, or other hygroscopic materials should never be placed in direct contact with critical metal surfaces since such materials tend to absorb and retain moisture next to the surfaces, finally causing corrosion. Provide always a water-vaporproof barrier between any critical metal surfaces and hygroscopic packing materials, and a waterproof or moisture-resistant barrier between all metal surfaces and hygroscopic materials.

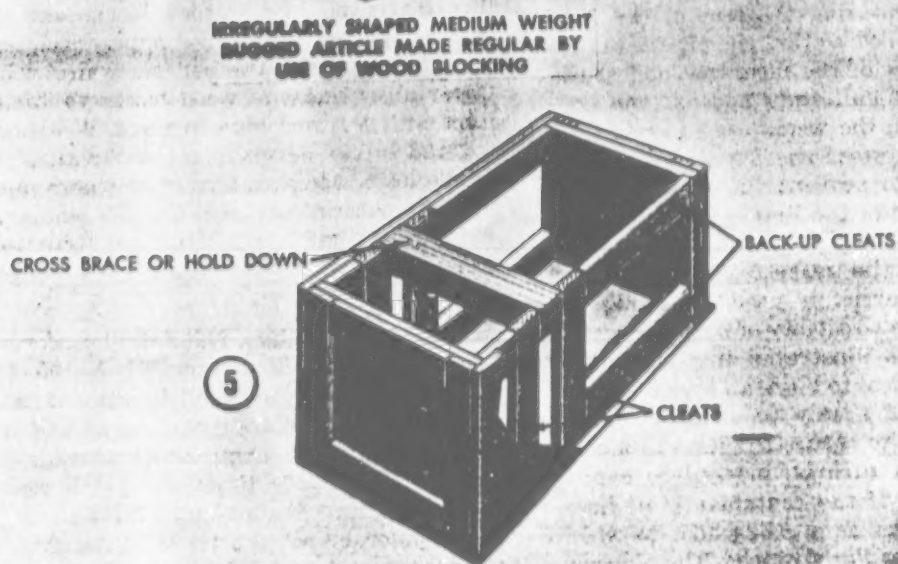
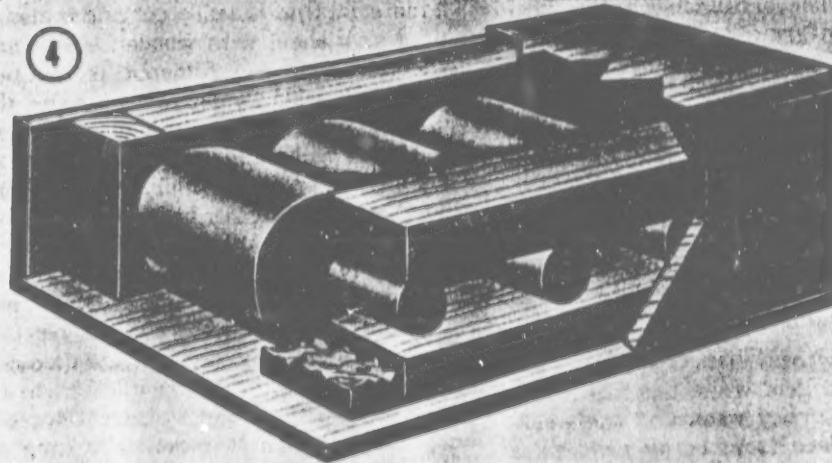
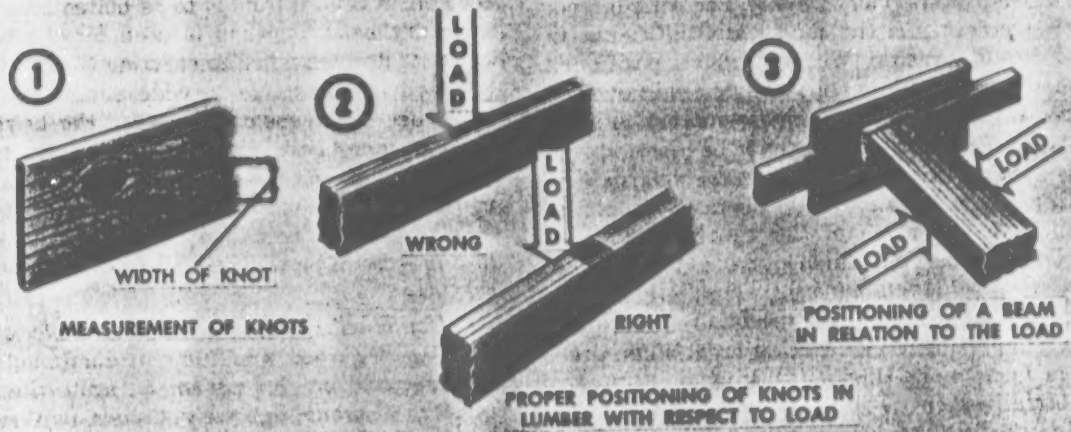
(2) *Defects in blocks and braces.* Wooden members used for blocking and bracing are often subjected to great stress and careful consideration must be given to any weakening defects. If the member functions as a beam or column, defects such as divergence of grain, knots, splits and decay should be avoided (para 3-1 and fig 3-2). This is especially important if the defect is located near the center of the piece, because of the great reduction in shock resistance. If a piece with a knot is used, the load is placed so that the knot is in compression as shown in (2), figure 1-14. Lum-

ber having knots of a diameter exceeding one-fourth the width of the piece should not be used (1 fig 1-14). The slope of grain in each piece should not exceed 1 inch in 10 inches of length, or splitting is likely to occur. Decayed wood is avoided under all circumstances because there is no way of determining how much the decay may have weakened the wood.

(3) *Size of wood braces or holddowns.* Braces or holddowns must be of sufficient size to withstand the shocks encountered. The size of a brace varies with the weight of the item, the length of the brace, and the type of loading. Table 1-3 used with figure 1-15, gives the recommended allowable load in pounds for the various sizes of braces and the various types of loading. For example, assume that the weight of the item is 72 pounds, the length of the brace is 24 inches, and the type of loading is the third type illustrated in figure 1-15 (loading in the center $\frac{1}{4}$ to $\frac{1}{2}$ of the unsupported length of the brace). For this type of loading, multiply the weight of the item by the factor $\frac{3}{4}$, as shown in figure 1-15. Three-fourths times 72 equals 54. In the column headed "Length of brace in inches," of table 1-3, find 24 inches and read to the right until a value near 54 is found. The heading for this column shows that the proper size of member and direction of loading is a 1 x 2-inch member used on edge, or a 1 x 4-inch member used flatwise.

(4) *Positioning loads on blocks and braces.* When wood blocking and bracing is used to secure heavy items, place the block so that the load rests on the end grain of the piece, whenever possible. If this cannot be done, the load should bear on the edge grain. When so placed, the maximum strength of the brace is used (fig 1-16). Since wood is relatively stable in dimension along the grain, there is little effect from shrinkage or swelling with a change in moisture content. The brace should, if possible, have its narrow face against the item so that its maximum stiffness is utilized. If a larger bearing area is required, and it becomes necessary to have the flat face of the brace against the item, the size of the brace must be increased (table 1-3). Lumber which is relatively wide for its thickness must be reinforced throughout its length to prevent twisting or buckling.

(5) *Using lumber as a mounting base.* If an item is to be secured to a base, and plywood is not available, use dimensional lumber. Bases of dimensional lumber should be constructed with sufficient cleats at right angles to the grain of the baseboards, and fastened with clinched nails to prevent the boards from splitting at the bolt holes. Strength of the bases must be adequate to with-



EXAMPLES OF BLOCKING AND BRACING APPLICATIONS

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Figure 1-14. Application of wooden blocks and braces.

stand any rough handling the pack may be likely to receive.

(6) *Securing lumber blocking.* Securing lumber blocking properly is the most essential factor in blocking and bracing. Wooden braces positioned between two faces of a container should never be secured with end grain nailing, toenailing, or similar methods, nor should they ever be inserted into notches cut into the container faceboards. Instead, the braces should be secured by cleats fastened to the faces of the container with a sufficient number of clinched nails. When pressures are great, or an increased nailing area is required, backup blocks are used to reinforce the cleats and give increased nailing area. When pressure is from more than one direction, a pocket cleat arrangement is used to hold the braces in position (3) fig 1-14. The backup blocks are positioned with their end grain in contact with the brace in order to make use of the high strength property of wood in compression parallel to the grain. The cleats and backup cleats (5) fig 1-14 are secured with clinched nails properly staggered at intervals along their length. Sometimes, however, bolts are used to fasten these members in place. This is especially desirable when the entire weight of the item thrusts against the block, or when the cleat supports a framework attached to one or more faces of the container.

d. *Plywood Blocking and Bracing.* Plywood is used to distribute the load when the face of an item is flat but structurally weak and the weakness prevents that face from being used as a bearing area. By covering the face of the item with a sheet of plywood, so that the plywood bears on stronger portions of the face, the load of the item is distributed uniformly against the container and injury to the weak face is prevented. The edges of the plywood sheet are padded with felt, if necessary, to prevent the plywood from marring the surface of the item. Plywood can be used for making pressure strips to distribute the load of an item on the gaskets when a floating water-vaporproof barrier is used. This method, which minimizes the possibility of barrier damage during shipment, is illustrated in figure 1-17. When it is not practical to block an irregular item to transfer the load evenly to all faces of the container, it is wise to secure the item to a solid base which may in turn be blocked to evenly distribute the load. If the container is of fiberboard, plywood serves as a good pallet to which the item may be bolted or strapped. The plywood, in turn, is securely blocked into the container by a holddown or top pad. Thin plywood is used to advantage where the blocking must be flexible to

conform to a curved surface. Plywood is used where thin material is required as a brace in tension. When an item is to be bolted to a base or auxiliary base, plywood is used for the base because of its resistance to splitting (fig 1-18). Since plywood is obtainable in wide panels, it is especially useful in base construction. For light items, $\frac{1}{2}$ - or $\frac{3}{4}$ -inch plywood should be used. For medium and heavy items, two or more pieces of plywood can be fastened together, or a series of strengthening cleats can be added to the panel. The cleats also may be of plywood to reduce the possibility of splitting.

e. *Combined Plywood and Lumber Blocking and Bracing.* Plywood and lumber, combined into a blocking and bracing assembly, unite the advantages of a strong, lightweight sheet material with a material that is easily cut and nailed. Plywood is used as a sheet with wooden blocks nailed to the sheet. The number, dimensions, and placement of the wooden blocks depend upon the shape of the item, its depth, the position of any projections, and the loads to be supported at the various bearing areas. The required thickness of the plywood depends upon the span between the blocks and the load to be distributed. The sheet of plywood must be stiff enough to resist bending so as to evenly distribute the weight of the item. Position the blocks upon the plywood sheet at places where the item can withstand concentrated loads. Wherever possible, locate the blocks and braces against the stronger portions of the item. Choose nails that are long enough to permit clinching after being driven through the wooden blocks and the plywood sheets. If clinching is impractical, drive the nails through the thinner piece first (fig 1-19). Cover all surfaces of wood blocks contacting the item with felt and glue in place. Where the felt-covered blocks normally contact critical surfaces of the item, use greaseproof or water-vaporproof barrier material between the felt and the item. Eliminate time consuming construction of a framework at the time of packing by using prefabricated blocking.

f. *Nails and Nailing.* Nails shall conform to the requirements of Specification FF-N-105. All nails that are not clinched shall be cement coated or etched. Unclinched nails shall be as long as practicable without splitting the material, but not shorter than three times the thickness of the member holding the nailhead for tenpenny nails and smaller, or not shorter than the thickness of the same member plus $1\frac{1}{2}$ inches for twelvepenny nails and larger. Nails loaded transversely to their length (lateral) in blocking and bracing joints need not be clinched. End grain nailing in solid wood or

Table 1-8. Brace Selection—Allowable Load in Pounds

LENGTH OF BRACE IN INCHES	THE ALLOWABLE LOAD IN POUNDS																IS FOR ALL GROUPS OF WOOD																			
	1 X 1	1 X 2	1 X 3	1 X 4	1 X 6	1 X 8	2 X 2	2 X 3	2 X 4	2 X 6	2 X 8	3 X 3	3 X 4	3 X 6	3 X 8	4 X 4	4 X 6	4 X 8																		
12	23	23	50	110	82	287	113	548	176	1313	234	2344	238	238	385	621	532	1186	827	2844	1104	5073	1005	1005	1388	1916	2149	4594	2871	8203	2646	2646	4106	5344	5475	1328
18	16	16	34	74	55	191	76	365	117	878	136	1562	159	159	257	414	354	791	551	1901	736	3361	669	669	925	1278	1434	3071	1914	5469	1764	1764	2738	4281	3650	7552
24	12	12	26	55	41	143	57	274	88	656	118	1171	119	119	193	310	266	593	411	1422	548	2532	502	502	694	958	1074	2297	1436	4102	1323	1323	2053	3172	2750	5664
30	10	10	21	44	35	115	45	219	70	529	94	937	95	95	154	249	213	475	332	1146	441	2029	402	402	555	767	861	1851	1148	3281	1059	1059	1643	2556	2190	4531
36	8	8	18	37	29	96	36	182	59	439	81	781	80	80	128	208	178	395	276	951	368	1691	335	335	465	638	720	1536	957	2734	882	882	1369	2121	1825	3776
42	7	7	15	32	23	82	32	157	50	379	67	670	68	68	110	175	152	340	236	821	515	1449	287	287	396	549	613	1326	820	2344	756	756	1178	1831	1564	3237
48	6	6	13	28	21	72	28	137	44	329	59	586	60	60	96	156	133	297	208	712	276	1268	251	251	347	480	540	1130	718	2051	662	662	1027	1588	1369	2832
54	5	5	11	25	18	64	25	122	39	293	52	521	53	53	84	138	118	263	186	634	248	1127	223	223	300	425	478	1024	638	1825	568	568	913	1414	1217	2517
60	5	5	10	22	16	59	23	110	35	264	47	467	48	48	77	127	106	236	163	572	221	1015	202	202	276	383	439	924	574	1641	529	529	821	1276	1095	2259
66	5	5	9	20	15	55	21	99	32	240	43	426	43	43	70	114	97	215	152	520	201	923	183	183	252	347	394	840	522	1491	481	481	747	1168	990	2060
72	4	4	8	18	14	48	19	92	29	221	39	391	40	40	64	104	89	198	135	478	180	845	167	167	231	320	360	772	479	1367	441	441	684	1066	915	1888
78	4	4	7	15	13	44	17	84	27	203	36	361	37	37	60	96	82	182	129	440	170	780	155	155	213	294	332	711	441	1262	407	407	632	982	842	1743
84	4	4	7	16	12	41	16	78	25	188	35	355	34	34	55	89	76	169	118	408	158	725	144	144	196	273	309	659	410	1172	378	378	587	910	782	1618
90	3	3	7	15	11	38	15	73	23	176	31	313	32	32	52	83	71	158	113	382	147	676	134	134	185	253	287	617	383	1094	353	353	548	832	730	1510
96	3	3	6	14	10	36	14	68	22	165	29	294	30	30	48	78	64	148	101	358	135	634	126	126	173	239	270	578	359	1025	331	331	513	798	684	1416
102	3	3	6	13	10	34	13	65	21	155	28	276	28	28	45	73	63	140	96	336	130	597	118	118	163	226	253	543	338	965	311	311	483	750	644	1333
108	3	3	6	12	9	32	13	61	20	147	26	261	27	27	43	70	59	131	90	319	123	564	113	113	154	213	242	515	320	911	294	294	456	711	608	1259
114	3	3	5	11	9	30	12	58	19	139	25	247	25	25	40	65	54	123	84	301	116	534	106	106	146	202	225	486	302	863	279	279	432	671	576	1192
120	2	2	5	11	8	29	11	55	18	132	23	235	24	24	39	62	53	119	79	286	110	507	100	100	139	192	214	462	287	820	265	265	411	638	548	1135

LUMBER CROSS SECTION SIZES AS SHOWN IN TABLE SHOWN ARE FOR ACTUAL OR DRESSED SIZES—EXAMPLE:

ARE NOMINAL. THE ALLOWABLE LOAD IN POUNDS AS $1\frac{1}{2} \times 3\frac{1}{2} = 2 \times 4$ ETC..

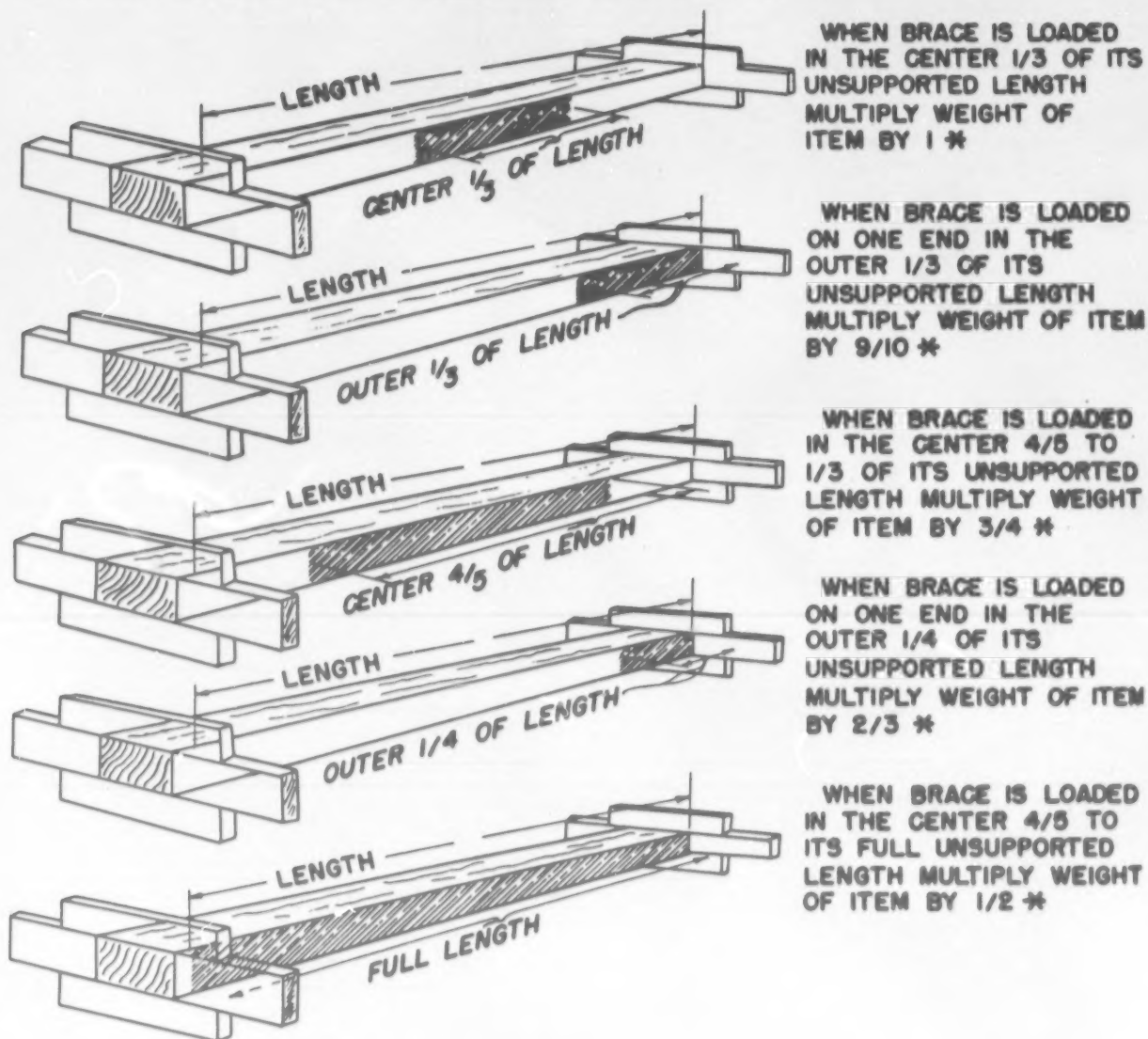
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edge nailing in plywood shall not be permitted. Nails shall be driven through the thinner member into the thicker member wherever possible. Nails shall not be subject to withdrawal stresses. Nails shall be driven not closer to the end of a piece of lumber than the thickness of the piece and not closer to its side than one-half its thickness. There shall be at least two nails in each joint. Lateral loading of nails for blocking and bracing shall be in accordance with table 1-4. Ends of blocks and braces shall not be fastened to a wood container by end-grain nailing, toe nailing, or similar methods but shall be fastened to a sturdy part of the container or held in place by parallel cleats or other side-grain nailing methods. Blocking and bracing shall be applied against areas of item(s) that are of sufficient strength and rigidity to resist damage. A description of the various types of nails and general requirements for their use are given in chapter 3 and illustrated in figure 3-4. Standard sinker and cooler nails are particularly well suited for use in blocking and bracing. Clout nails with large heads similar in shape to roofing nails, are recommended where plywood of one-half of an inch or less is used. Nails used in blocking and bracing should be coated or chemically etched (para 3-1b), especially if the nails cannot be clinched. If nails fail when subjected to forces of direct withdrawal, they usually fail suddenly. Whenever possible, apply nails so that they

are subjected to forces of lateral displacement rather than direct withdrawal, that is, the direction of the nails is perpendicular to the direction of the load, rather than in line with the direction of the load.

g. Bolts and Bolting. Carriage or step bolts conforming to Specification FF-B-584, Type I, Class 1, Style a or c, shall be used as fastenings for wood or plywood blocking and bracing where necessary to facilitate disassembly for removal of container contents. Bolts shall also be used for fastening blocking and bracing members that are too thick for proper fastening with nails. Bolt holes in wood or plywood shall be of the same diameter as the bolts. Bolts commonly used for blocking and bracing are machine bolts, carriage bolts, and step bolts (para 6-2e). Step bolts are preferred for this use because of their larger head diameter. J- or U-bolts are used for special conditions where regular bolts cannot be applied (fig 1-20). Tie rods and J-bolts are actually extended bolts, applied in pairs either vertically (fig 1-21) or diagonally (fig 1-22), and are used where standard length bolts would not apply. See table 1-5 for the suggested allowable load for the various sizes of bolts. The following precautions should be observed in the use of bolts:

(1) Items such as machines or subassemblies having bolt holes in parts which are sturdy



* VALUE OBTAINED BY MULTIPLYING WEIGHT OF ITEM BY ABOVE FACTOR IS USED DIRECTLY IN BRACE SELECTION TABLE TO FIND CORRECT SIZE OF BRACE

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Figure 1-15. Types of Loading (for use with table 1-3).

enough to resist breakage when rough handled should, if practical, be bolted to one face of the container.

(2) If nonprecision bolt holes are involved, the diameter of the bolt should be the nearest standard size consistent with the diameter of the hole.

(3) If precision bolt holes are involved, precautions should be taken to insure that precision

fitting bolts of the proper fit and characteristics are used to prevent marring or elongation.

(4) Lag bolts should not be used for blocking and bracing.

(5) Holes bored through containers or mounting bases must be the same size as the diameter of the bolts to be used.

(6) When mounting items to container bases

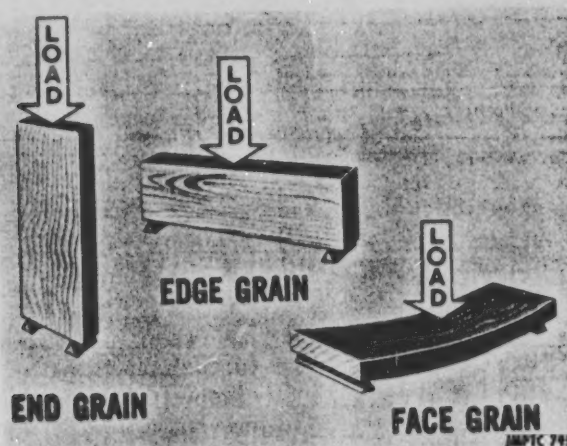


Figure 1-16. Positioning load according to grain of wood.

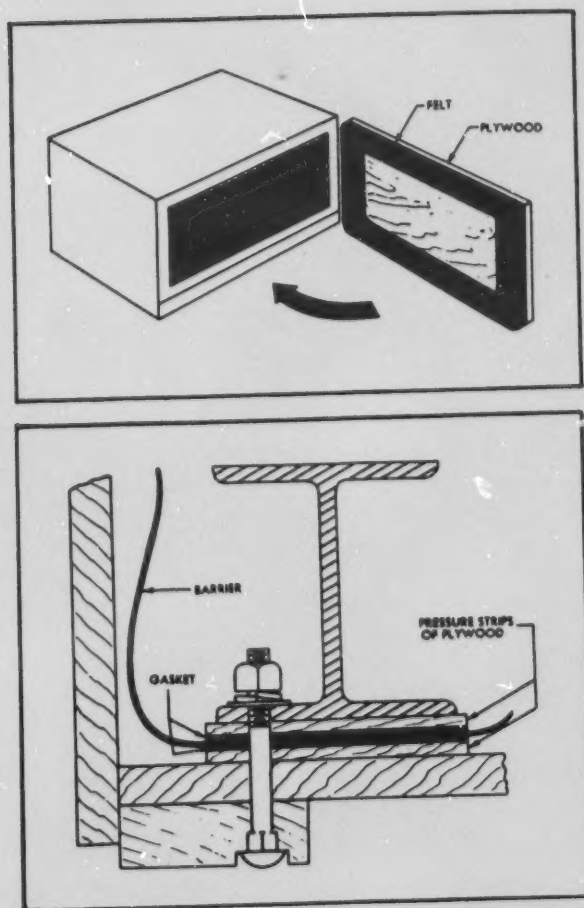


Figure 1-17. Protection for barrier at holddown.

equipped with skids, extend the bolts through the skids, whenever practical, and in such instances countersink the bolt in the outer surface of the rubbing strip.

(7) Use standard cut washers under the nuts to decrease the possibility of the bolt pulling through the wood.

(8) Make sure that the nuts do not come loose intransit by turning the nut securely on the bolt, and either upsetting or nicking the threads of the bolt beyond the nut; applying asphaltum, paint, or lacquer on the threads; using lock nuts; or using cotter pins with the nuts.

(9) Bolts and nuts that are not corrosion-resistant must be completely covered with P-1 or P-19 corrosion preventive compounds. The compound must be thoroughly set before the bolts are used.

(10) Where the item has strong frame members fairly close to the face of the container, consider using U- or J-bolts. Whenever feasible, the nut end of the U- or J-bolt should be on the outside of the container. In such cases, it is especially important to upset the threads or otherwise prevent the nuts from loosening.

(11) Use tie rods as extended bolts to secure items when J- or U-bolts are unsuitable. Place tie rods in pairs, either diagonally or vertically as may be necessary. Attach the tie rods to a reinforced point of the container and use them with washers bearing against the wood. Be sure the tie rods pass through the base at an angle which will not cause bending or kinking of the rod. Any kinking will weaken the rods and increase the possibility of failure.

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Table 1-4. Allowable Lateral Loads for Unclinched Cement-Coated or Etched Common Wire Nails When Used for Blocking or Bracing

Species of wood	Load, pounds per nail								
	4d	6d	8d	10d	12d	16d	20d	30d	40d
White pine, ponderosa pine, spruce, and other group I woods	14	17	21	25	26	29	38	42	48
Southern yellow pine, Douglas fir, western larch, and other group II woods	21	26	32	39	40	45	58	65	73
Oak, maple, birch, beech, ash, and other group III and IV woods	26	32	40	48	49	55	71	80	90

¹ Group classification of species not specifically named shall be in accordance with Standard MIL-STD-731.

Table 1-5. Suggested Allowable Lateral Loads for Bolts—Impact Loading

Diameter of bolt (inch)	Allowable load (pounds)
3/8	35
1/2	90
5/8	150
3/4	200

(12) When anchoring heavy castings, tighten the nuts down equally so that there is no undue strain on any portion of the casting. After nuts have been tightened securely, it is advisable to back off the nuts one-fourth to one-half turn to relieve any internal stress on the casting.

1-13. Anchoring

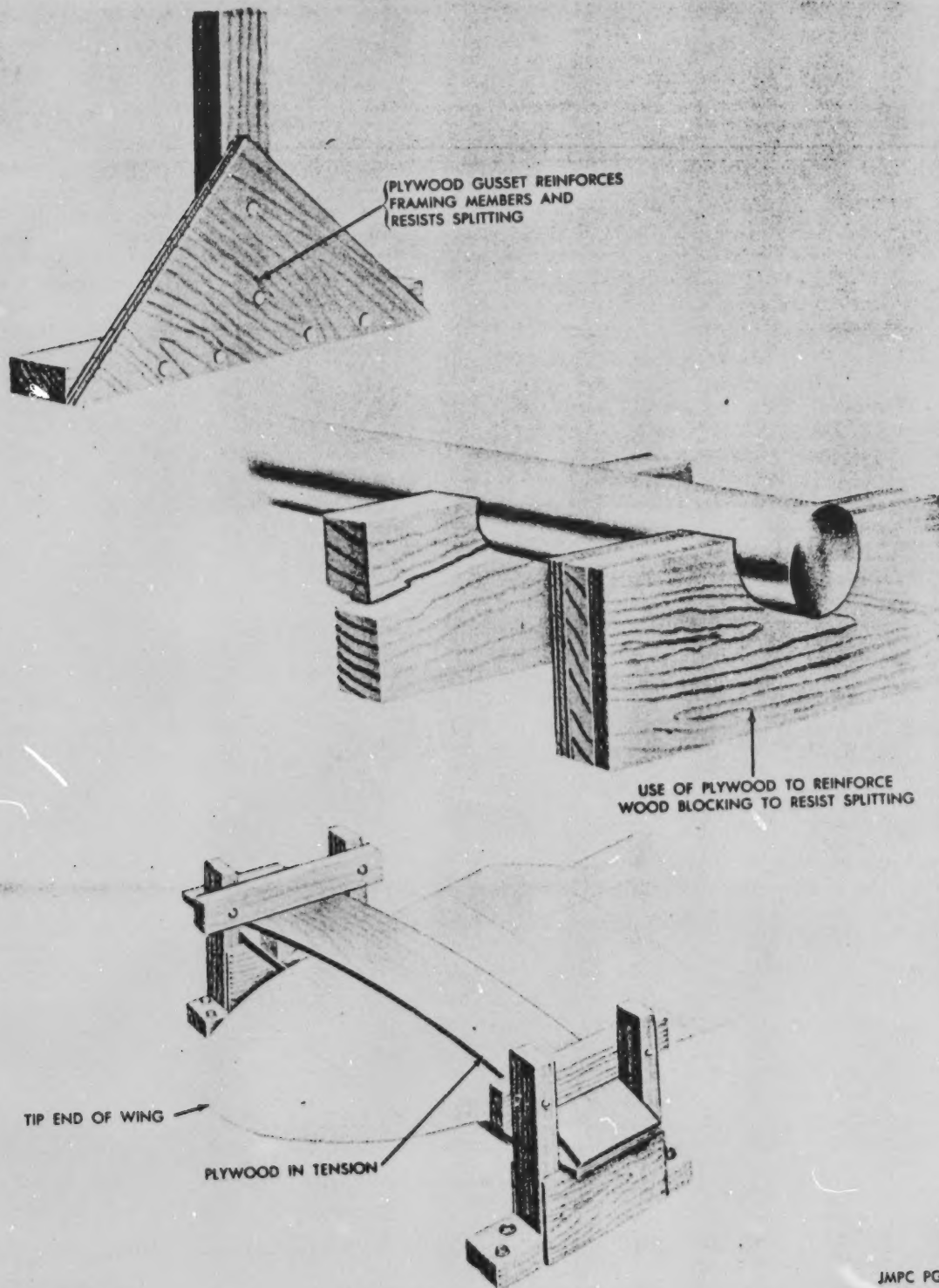
Anchoring of heavy items should be accomplished by securing the item to a base by tension devices, either by bolts through mounting bolt holes on the item (bolting down); or by metal strapping, cables, tie rods, chains, wire, or other tension devices attached to, or applied over, the item (tiedown or holddown); or by both. The same washer requirement as specified for bolts of equal diameter should apply to tie rods (a below).

a. *Anchor Bolts.* Carriage or step bolts conforming to Specification FF-B-584, type I, class 1, style a or c, should be used. Articles having mounting holes in areas that can withstand rough handling without breakage shall be bolted to either the base of the container or an auxiliary base. The bolt heads of anchor bolts (those holding the item to the container base or the auxiliary base) should be on the outside of the container when an item is bolted to the base of the container, otherwise on the underside of the auxiliary base. The heads of all anchor bolts shall bear against a wide washer conforming to Specification FF-W-92, type A or B, grade I, class A, medium size, except that the minimum diameter or minimum size of square bolts shall be as specified in table 1-6 when the

member adjacent to the bolt head is wood. Bolts through mounting bolt holes shall form a snug fit, except that precision holes shall be bushed to prevent damage by anchor bolts. In a crate where the item is bolted to a skid-type base, the anchor bolts shall pass through the skids or through loadbearing members that are bolted to the skids. Bolt holes in wood should be of the same diameter as the bolts. The maximum allowable load for anchor bolts required and the minimum size of wood-bearing washers should be as specified in table 1-6. When the weight of the item exceeds that which can be anchored adequately using allowable loads shown in table 1-6 and all of the available mounting bolt holes on the item, the excess weight shall be taken care of by tiedown provisions specified herein. After the nuts have been tightened, the exposed bolt thread should be painted with asphalt or unthinned white lead unless locknuts or self-locking nuts are used. The required size and quantity of bolts used as tie rods or for anchoring the ends of the tiedown tension members should be in accordance with table 1-6. Lag bolts should not be used in lieu of carriage or step bolts.

b. *Metal Brackets or Frames.* Many items have attachment points which provide facilities for bolting, but often these points are not located on the base, so that brackets must be used to fasten the item to the container. In those situations where tie rods or U- or J-bolts cannot be used, specially constructed brackets, sleeves, or frames made entirely of metal, wood, or a combination of these, are used to act as intermediate connections between the item and the container. These frames or brackets must be designed with sufficient strength and fastening facilities to hold the item to the container securely. Select sleeves that will fit the interior of the container snugly and will have sufficient structural strength to support the load (fig 1-23).

c. *Metal Strapping.* Metal strapping used to tie down an item to the base or other face of the



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Figure 1-18. Uses of plywood for blocking and bracing.

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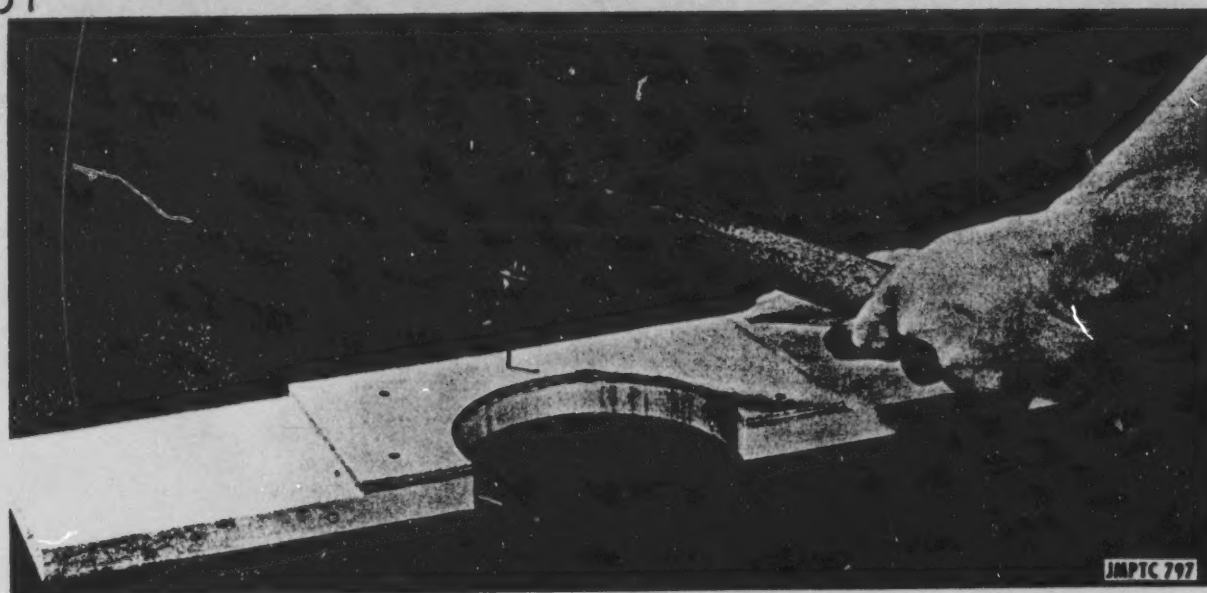


Figure 1-19. Plywood nailed to wood for reinforcement.

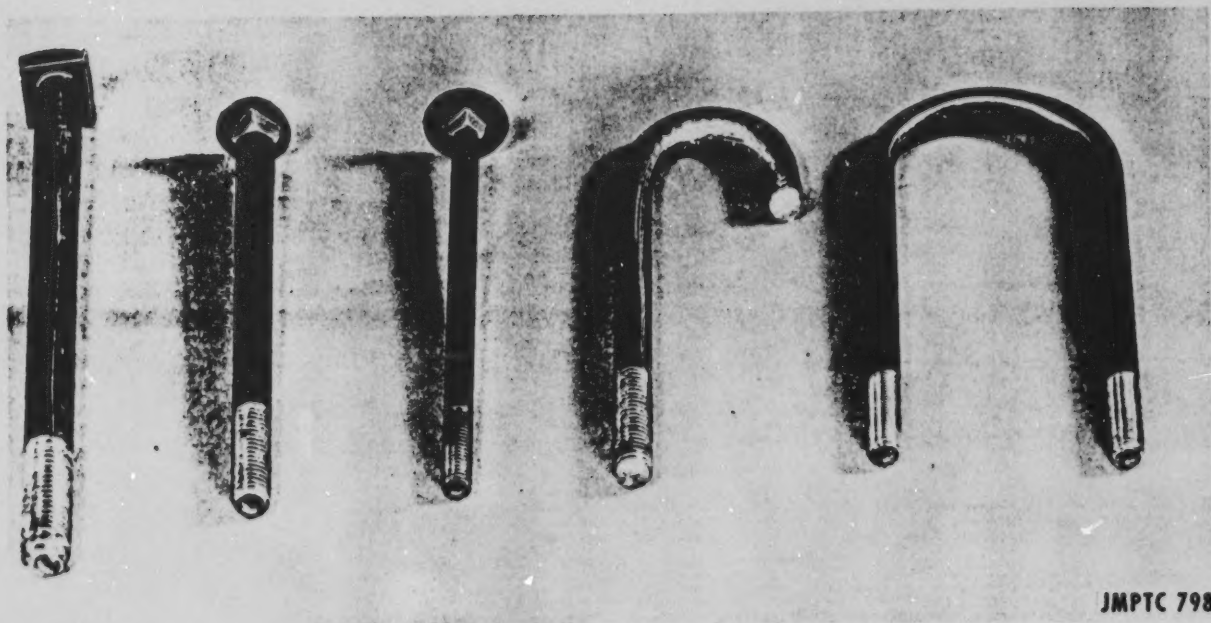


Figure 1-20. Bolts for blocking and bracing.

container or to an auxiliary base should be either flat or round wire steel strapping conforming to Specification QQ-S-781. Tiedown strapping shall be securely attached to or looped over the item. It shall be anchored to the container or auxiliary base either by looping around a load-bearing member or by utilizing steel slotted anchor plates

secured to the container or auxiliary base. Padding material or suitable edge protectors, as applicable, shall be used under the straps to prevent damage to the item. Whenever possible, all strands holding down an item shall be of approximately the same length. Maximum allowable loads for each strand of tiedown strapping shall be

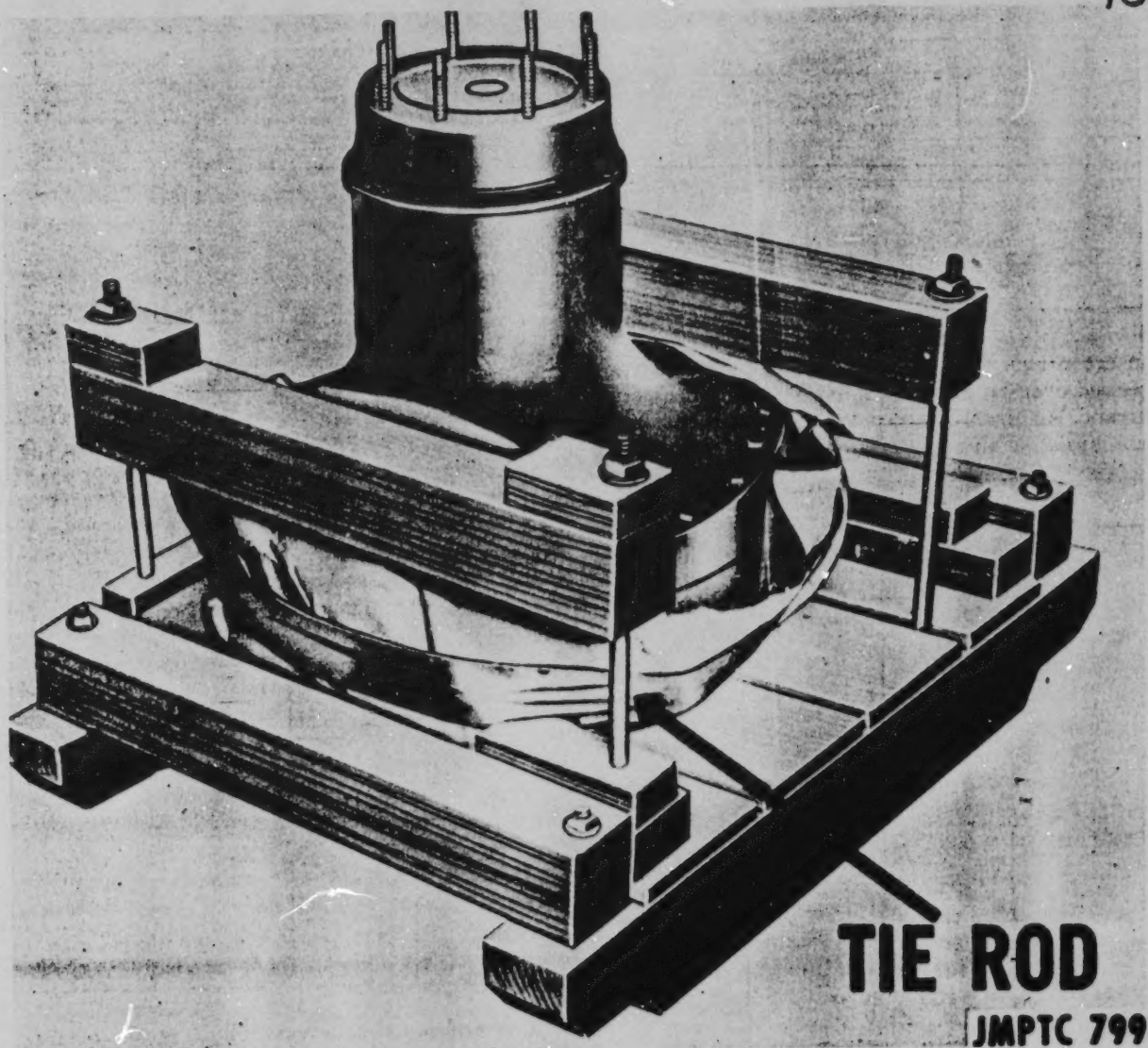


Figure 1-21. Vertical use of tie rods.

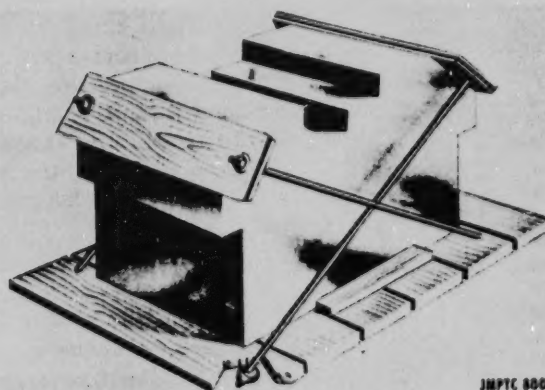


Figure 1-22. Diagonal use of tie rods.

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Table 1-6. Maximum Allowable Loads and Minimum Sizes of Wood-Bearing Washers for Anchor or Tiedown Bolts

Diameter of bolt	Wood-bearing washers		Maximum allowable load per bolt		
	Minimum diameter of round	Minimum size of square	Items weighing 200 pounds and less	Items weighing 200 to 3,000 pounds	Items weighing over 3,000 pounds
<i>Inch</i>	<i>Inch</i>	<i>Inch</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1/4	1.35	1.00	10	-----	-----
5/16	1.75	1.25	30	-----	-----
3/8	2.10	1.50	50	75	-----
1/2	2.85	2.10	100	150	300
5/8	3.60	2.65	150	225	450
3/4	4.70	3.25	-----	375	750

in accordance with table 1-7. Each tiedown strap passed over an item should be considered as one strand. All tiedown strappings shall be tensioned and sealed or tied securely.

Table 1-7. Maximum Allowable Loads for Each Strand of Strapping

Size of flat strap	Minimum diameter of round strap	Minimum length of hold down straps	Maximum allowable load
<i>Inch</i>	<i>Inch</i>	<i>Inches</i>	<i>Pounds</i>
3/8 x 0.020	0.10	10	22
		20	44
		30	66
		40	88
		50	110
1/2 x 0.020	0.12	10	30
		20	60
		30	90
		40	120
		50	150
5/8 x 0.020	0.13	10	37
		20	75
		30	112
		40	150
		50	187
3/4 x 0.020	0.135	10	43
		20	86
		30	129
		40	172
		50	215
3/4 x 0.023	0.148	60	258
		70	300
		10	50
		20	100
		30	150
3/4 x 0.035	0.183	40	200
		50	250
		60	300
		70	350
		80	400
		90	450
		100	500
		30	225
		40	300
		50	375
		60	450
		70	525
		80	600
		90	675
		100	750
		120	900

Table 1-7—Continued.

Size of flat strap	Minimum diameter of round strap	Minimum length of hold down straps	Maximum allowable load
<i>Inch</i>	<i>Inch</i>	<i>Inches</i>	<i>Pounds</i>
1-1/2 x 0.035	0.258	140	1,050
		160	1,200
		180	1,350
		200	1,500
		50	750
		60	900
		70	1,050
		80	1,200
		90	1,350
		100	1,500
		120	1,800
		140	2,100
		160	2,400
		180	2,700
		200	3,000
		240	3,600
		280	4,200
		320	4,800
		360	5,400

d. *Strapping Precautions.* Metal strapping may be the only convenient way in which an item or container can be secured or reinforced (fig 1-24). Metal strapping may be either flat steel or round wire. Both kinds of strapping are tensioned and preferably sealed with specially designed tools. If this is not possible, flat strapping can be held in place with anchor plates and round wire strapping with special drivescrews and staples. General precautions on the use of metal strapping which apply to both flat steel and round wire are as follows:

(1) Where possible, the item and its support must be completely encircled. When it is impossible to do this, anchor the two ends of the metal strapping as follows:

(a) For flat strapping, anchor the two ends of the strap to the container base with anchor plates, or if the strap is designed for nailing, nail

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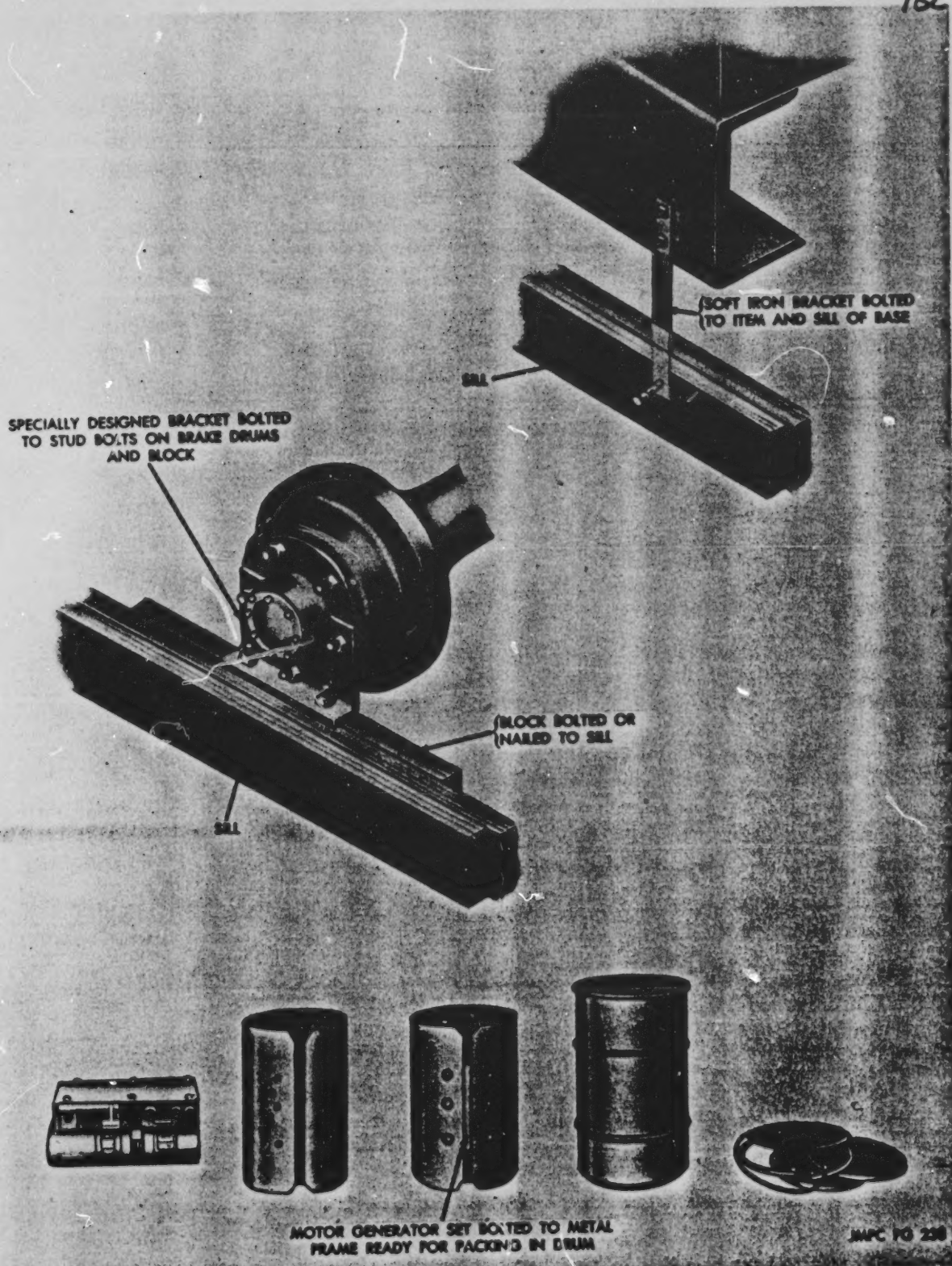


Figure 1-23. Use of metal brackets, frames, and sleeves.

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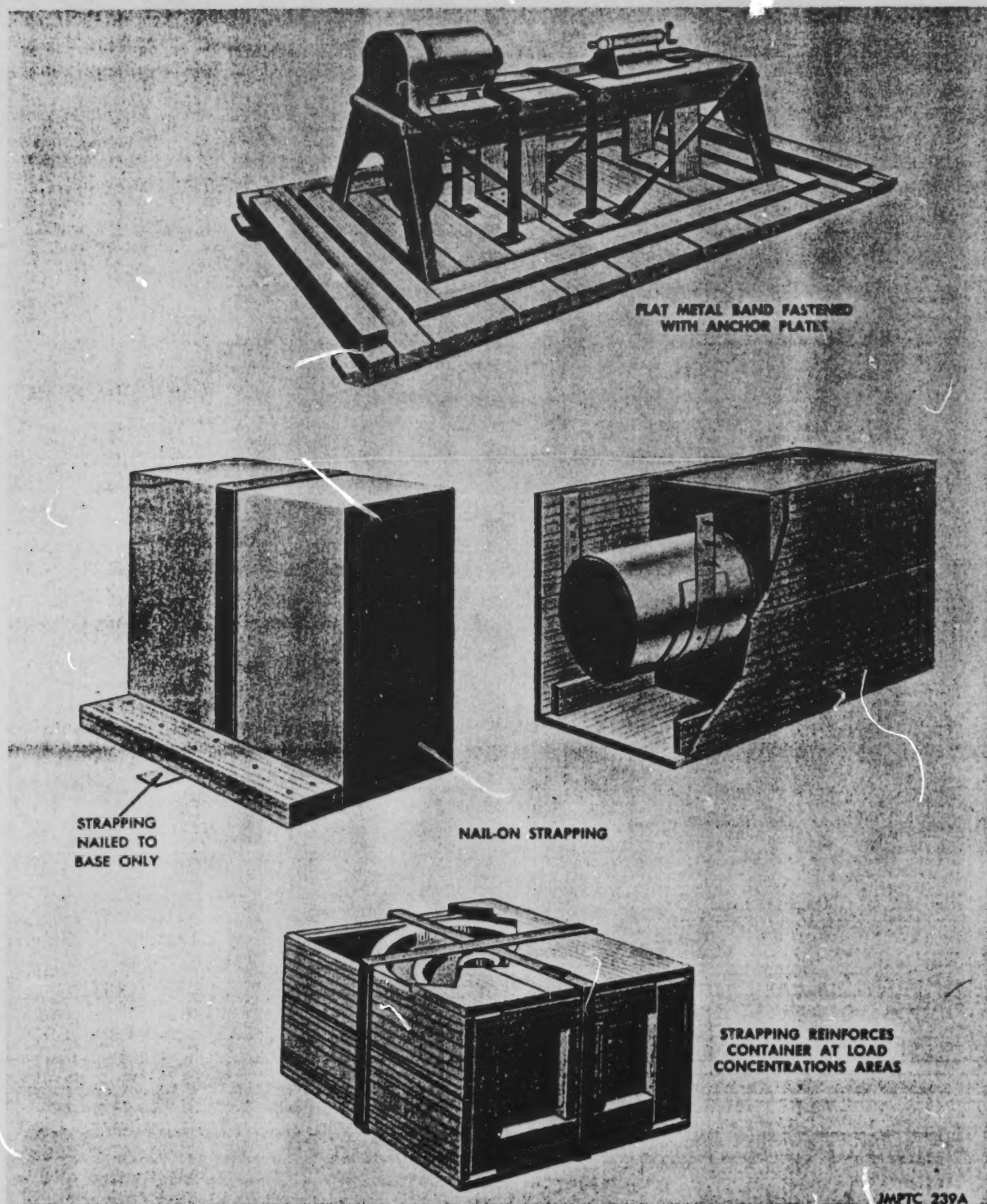


Figure 1-24. Use of metal strapping for bracing and anchoring.

the ends of the strap to the container base. Place the nails so that the straps exert a pull at right angles to the nail axis.

(b) For round wire, anchor the two ends of the round wire to the container with drivescrews and staples. Loop the wire around the shank of the drivescrew and further anchor the wire by means of staples. Be sure the wood is thick enough to hold the entire length of the drivescrew and that the drivescrew is of adequate gauge to carry the load. When drivescrews are used, place them so that the wire exerts a pull at right angles to the drivescrew axis.

(2) Apply tension to the strap with a tension tool and seal the strap in the customary manner. Use a one-piece strap wherever possible.

(3) Straps should be placed only on those strong portions of the item which can withstand the impact load and weight of the item.

(4) Where strapping passes over a sharp edge of the item, use corner protectors, if necessary, to prevent the strapping from becoming fractured.

(5) Protective materials should be used between the item and the strap if the strap is likely to scratch or otherwise injure the item.

(6) Arrange strapping on the container, where possible, to further reinforce blocking and bracing or anchoring of the item within the container.

(7) Use annealed strapping only for lighter items, since it stretches more readily than the more highly tempered tension strapping.

e. Minimum Lengths of Straps. The minimum total length of straps shown in table 1-7 does not include that portion of material used to make a secure fastening at the ends of each strand but is the sum of, and does include, all lengths of material between such fastenings. Overall lengths of each strand shall be adequate to permit fastening as specified in *c* above.

f. Maximum Allowable Loads. The maximum allowable loads shown in table 1-7 are based on available energy of 8,640 inch-pounds per cubic inch of strap in tension and an assumed drop height of 30 inches, as established by QQ-S-781. If greater loads than those shown in table 1-7 are to be tied down or if other sizes of strap are used, additional strapping shall be applied on the basis of 300 pounds of load per cubic inch of strap in tension.

1-14. Strapping Reinforcement for Containers

In addition to the use of metal strapping as reinforcement for blocking or bracing, its widest

use is for reinforcement of exterior wooden containers. Only tempered, high tensile strength, flat steel or round wire strapping should be used as wood container reinforcement, except in limited instances such as reinforcing of a crate corner where annealed nail-on-type flat steel strapping is employed. For export shipments, bare metal strapping should not be used due to its lack of corrosion resistance. Each military container specification has a section or an appendix devoted to closure and strapping. It is important that the instructions contained in these publications be observed. Summaries of these instructions are to be found in chapters 2, 3, and 6 of this manual under specific containers.

a. Web Strapping. The use of web strapping to tie down an item to a base, to other faces of the containers, or to a built-up frame, is *NOT* considered a good practice. Web strapping has a tendency to shrink or stretch with change in moisture content, thereby losing its ability to hold the item firmly in place. It is hygroscopic, and may cause corrosion to contacting metal surfaces, and it is often difficult to anchor properly.

b. Reinforced Tapes for Packing. Various kinds of tapes have been developed with longitudinal filament reinforcing strands to provide high tensile strength. When such tapes are properly applied to containers or bundled items, significant increases in resistance to rough handling are attained. These tapes consist of either a paper or plastic backing, which has been coated on one side with an insoluble pressure-sensitive adhesive, or a gummed adhesive that is activated by a solvent. The high tensile strength of the tape is produced by filaments of rayon, glass, or other fibers that have been lineally aligned and embedded in the backing material. When the tape is applied to the container so that the direction of the rough handling stresses are parallel to the embedded filaments of the tape, considerable container strengthening results. Longitudinal tensile strength of these tapes may be over 500 pounds per inch of width. Some of the advantages claimed for their use are that sufficient tensile strength and elastic properties are present to enable a package or pack to be highly resistant to shock loads. The adhesive holds the tape to the area of application and thus prevents slippage during handling. These tapes do not easily snag and do not interfere with stacking and handling of containers. No special equipment is needed for their application. They provide a means of reducing pilferage.

(1) Reinforced paper, gummed tape (PPP-T-

45). There are three types and two classes available. Type I (reinforced, asphaltic laminated) and Type II (reinforced, nonasphaltic laminated) are intended for use in so called single strip closure under the Uniform Freight Classification Rule 41, section 7. Types I and II are used for closure of fiberboard boxes for domestic shipment and storage and for securing wrappers of packages. Type II shall be used where the presence of asphalt would have a deleterious effect on the contents, such as food products. Type III is intended for use in general sealing of cartons, fiberboard boxes, and wrappers and for banding paper and paper products. Class 1 (strippable) is used when ease of opening and removal of the tape is desired. Class 2 (nonstrippable) is used when removal of the tape from boxes is not necessary for reuse.

(2) *Filament reinforced, pressure tape (PPP-T-97)*. These tapes are supplied in four types based on tensile strength. Type I (low tensile strength) has a minimum tensile strength of 160 pounds per inch of width. Type II (medium tensile strength) has a minimum tensile strength of 240 pounds per inch of width for Class A, and 300 pounds per inch of width for Class B. Type III (high tensile strength) has a minimum tensile strength of 425 pounds per inch of width. Type IV (high tensile strength, weather-resistant) has a minimum tensile strength of 400 pounds per inch of width. Only Type II has two classes, based on the transparency of the tape. Class A is opaque or nontransparent, and Class B is transparent enough to allow reading of printed matter through one layer of the tape. These tapes are intended for use in securing packages and reinforcing bundles and containers. Types I, II, and III should not be used where immersion in water or prolonged exposure to weather may occur. Type IV should be used where immersion in water or exposure to weather is anticipated.

c. Reinforced Tape Application Guidelines. There are no existing use documents that prescribe the exact kind, width, quantity, and method of application for high tensile strength tapes. Each application must be considered as a specific design problem. Only general guidelines can be given to assist in solving this problem. Some basic rules that may be helpful are as follows:

(1) Do not use a wide tape if a narrower tape is strong enough to accomplish the intended purpose.

(2) Do not use completely encircling bands on large containers.

(3) If it is anticipated that high humidity conditions or excessive moisture will be encoun-

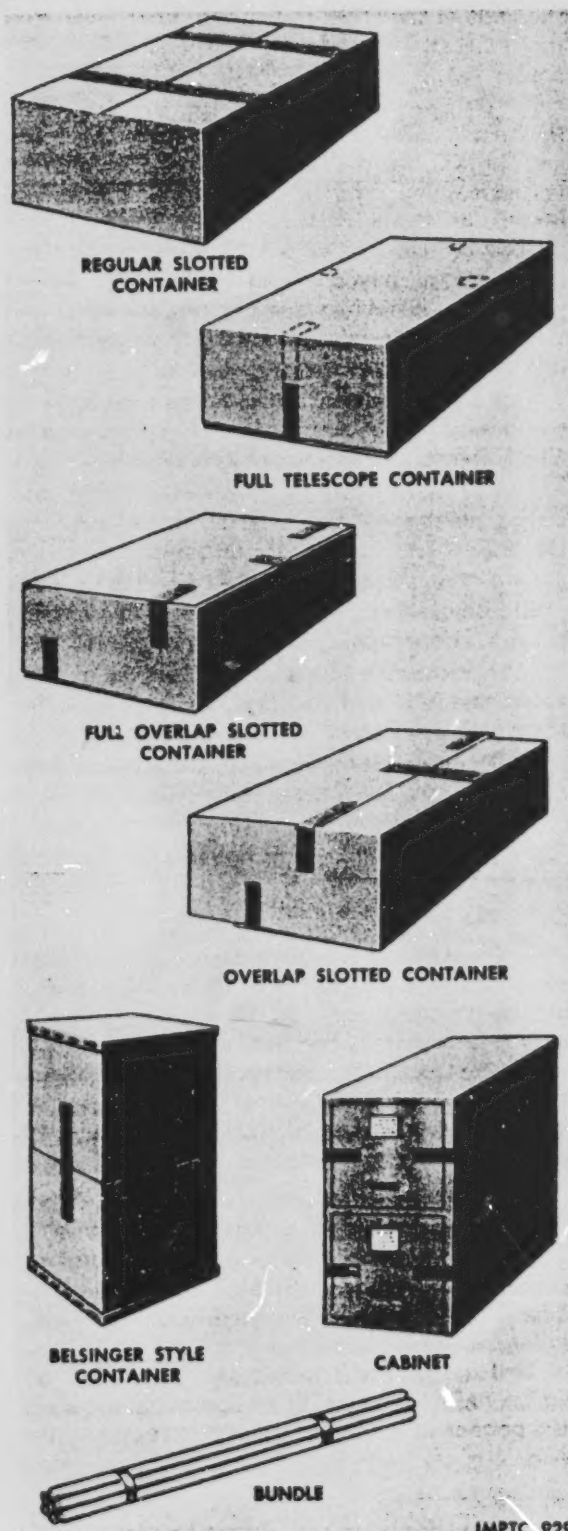


Figure 1-25. Use of filament reinforced tape.

Table 1-8. Number of Tape Strips (Minimum) Which Must Cross a Seam or Scoreline Requiring Closure or Reinforcement

Seam or scoreline length (inches)	Regular slotted boxes, full and overlap flap boxes, etc.	Telescope and 3-piece boxes (Belsinger style, etc.)
Up to 15 inclusive	2	1
Over 15 to 30	2	1
Over 30 to 60	3	2
Over 60 to 90	4	3

tered in shipment or storage, use tapes with water-insoluble adhesives.

(4) The adhesion of tapes to the surface of a container will depend upon the condition of the surface. Hence, in strip applications, the strips should be long enough to provide sufficient adhesion to take advantage of the full potential strength of the tape. This should require at least 6 or more inches of good contact between the tape and the container surface. The tape length should be equally divided over a seam, scoreline, or other point of application.

(5) In using reinforced paper gummed tape (PPP-T-45) for sealing containers shipped under the jurisdiction of the Interstate Commerce Commission, only the center seam of a container needs to be sealed. This is accomplished by using a strip at least 3 inches wide which must extend no less than 2½ inches over each end of the container.

(6) In using filament reinforced, pressure-sensitive tape (PPP-T-97), the following information will serve as a guide in its use. It should be recognized that special conditions will necessitate occasional deviations from these recommendations in the interest of economy or good practice. The filament reinforced, pressure-sensitive tapes are intended for use in reinforcing fiberboard or fiberboard surfaced containers, strapping, bun-

dling, and other miscellaneous applications. Type I, characterized by high elongation and low tensile strength, is best suited for strip reinforcement of containers and anchoring moving parts. Type II with lower elongation but high tensile strength, is also suited for closures. Type III, with higher tensile strength and low elongation, is most effectively used in complete wraparounds such as bundling and other forms of circumferential binding. Type IV should be used where weather resistance is required and should be used in the same lengths as the type it replaces. These tapes should be applied in continuous strips. Typical applications are shown in figure 1-25. Table 1-8 shows the proper number of reinforcing strips to be applied to each seam or score-line requiring closure or reinforcement. Table 1-9 shows the proper width of tape strip. Tape should be smoothly and firmly adhered to surfaces which are relatively smooth and nominally free from dust, dirt, grease, and moisture. Care should be taken to avoid excessive handling of tape adhesive surfaces, particularly at the ends of the strips. Such excessive handling might contaminate the surface of the adhesive and reduce its ability to bond firmly.

(7) The high tensile strength tapes are also used for bundling of rods, shafts, or tubular objects for easier handling. Table 1-10 shows the correct amounts of Type III (PPP-T-97) tape for use in bundling. The tape should be applied with sufficient hand tension to "snug" the bundle and secure maximum contact between the tape and the bundled items.

(8) Palletization may be accomplished by the use of a horizontal band of Type III (PPP-T-97) tape place around the top of the palletized items. One inch of tape width is sufficient to hold a layer of objects which may weigh many hundreds of pounds. If adhesion to the palletized items is

Table 1-9. Width of Tape Strips in inches (Minimum)

Gross weight	Number of tape strips used per package (in case of slotted boxes, divide number of strips per package by 2 since closure is needed on both top and bottom of box). Strips which start on a side or end panel, traverse the top or bottom seam, and terminate on an opposite side or end panel may be considered as two strips.						
	2	3	4	5	6	7	8
Pounds							
Up to 20 incl	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 20 to 40 incl	3/4	3/4	1/2	1/2	1/2	1/2	1/2
Over 40 to 60 incl	1	1	3/4	3/4	1/2	1/2	1/2
Over 60 to 80 incl	1-1/2	1-1/4	1	1	3/4	3/4	3/4
Over 80 to 100 incl	1-3/4	1-1/2	1-1/4	1	1	3/4	3/4
Over 100 to 120 incl	2	1-3/4	1-1/4	1-1/4	1	1	3/4
Over 120 to 140 incl		2	1-1/2	1-1/4	1	1	1
Over 140 to 160 incl			1-3/4	1-1/2	1-1/4	1	1
Over 160 to 180 incl			2	1-3/4	1-1/2	1-1/4	1
Over 180 to 200 incl				2	1-3/4	1-1/2	1-1/4
Over 200 to 240 incl					2	1-3/4	1-1/2

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Table 1-10. Tape Strips Used in Handling Rigid Materials¹

Gross weight of bundle	Type III tape band width in inches (minimum)									
	Number of encirclements (Example: Three encirclements could refer to either three separately located single wrapped bands or to one band which completely overlaps itself three times.)									
Pounds	1	2	3	4	5	6	7	8	9	10
Up to 20 incl	3/4	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 20 to 40 incl	1	3/4	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 40 to 60 incl	1-1/4	1	3/4	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 60 to 80 incl	1-1/2	1-1/4	1	3/4	3/4	1/2	1/2	1/2	1/2	1/2
Over 80 to 100 incl		1-1/2	1-1/4	1	3/4	3/4	3/4	3/4	3/4	3/4
Over 100 to 150 incl			1-1/2	1-1/4	1	3/4	3/4	3/4	3/4	3/4
Over 150 to 200 incl				1-1/2	1-1/4	1	3/4	3/4	3/4	3/4
Over 200 to 300 incl					1-1/2	1-1/4	1	3/4	3/4	3/4
Over 300 to 400 incl						1-1/2	1-1/4	1	1	1
Over 400 to 500 incl								1-1/2	1-1/4	1

¹ If material to be bonded is somewhat flexible, tape widths may be reduced by 25 to 50 percent. In no case should less than 1/2 inch tape be used.

deemed poor, a 16-inch overlap of the tape on itself is recommended. Load unitizing is accomplished in much the same manner as palletizing, except that placement of the tape reinforcing strips will vary according to the practical considerations of the loading requirement.

1-15. Cushioning

a. Cushioning Defined. Cushioning is the protection given to items against physical and mechanical damage by means of appropriate materials which absorb the energy of shocks and vibrations through a gradual but increasing resistance to the movement of the item. The energy from shocks and impacts is absorbed when the cushioning material is compressed, which in turn increases the pressure upon the entrapped air within the cushioning material, resulting in a damping or minimizing of the force to the item.

b. Cushioning Versus Blocking and Bracing. The distinction between cushioning and blocking and bracing is that cushioning permits controlled movement of the item within the container, while blocking and bracing usually is designed to prevent movement of the item within the container.

c. Cushioning and Corrosion. Where applicable cushioning should be used in one or more of the following ways to provide necessary physical protection. Cushioning materials shall be separated from surfaces which might be corroded at points of contact by either noncorrosive wrapping paper conforming to Specification MIL-P-130 or greaseproof barrier material conforming to Specification MIL-B-121, Grade A. If a noncorrosive cushioning material is used, the wrap is not required. Cushioning materials containing asphalt shall not be permitted to come in direct contact with highly finished, varnished, or lacquered surfaces.

d. Flotation or Suspension. Delicate or fragile items should be protected against shock and vibration by flotation or suspension within the shipping container by suitable cushioning materials. These materials may be in sheet form applied to give support at top, bottom, sides, and ends of the item. For items in sturdy cabinets, cases, consoles, or packed in an inner box, the cushioning material may be in the form of prefabricated corner pads. Materials shall be bound fiber conforming to PPP-C-1120; fiberboard conforming to PPP-F-320; wood excelsior conforming to PPP-E-911; fibrous glass conforming to MIL-C-17435; cellulosic material conforming to PPP-C-843; expanded polystyrene conforming to PPP-C-850; polyurethane foam conforming to MIL-P-26514; or such other materials specified in the procurement documents.

e. Abrasion Protection. Protection against abrasion should be provided for highly finished or easily marred surfaces by wrapping or covering with cushioning material. Surfaces that might be damaged by contact with cushioning material should be separated therefrom by a covering of noncorrosive paper conforming to MIL-P-130 or MIL-P-17667 or greaseproof barrier material conforming to MIL-B-121, Grade A. For specialty items requiring protection beyond the above, kraft paper with a cohesive coating should be applied.

f. Coatings and Barriers. Protection should be provided for strippable compound coatings and for greaseproof, waterproof, or water vaporproof barriers at points of contact with blocking, bracing, or projecting members of containers. Cushioning materials should be applied to reduce the static pressure at points of contact to 30 pounds or less per square inch.

g. Moisture Resistance. Unless otherwise specified in the product specification, cushioning mate-

rial conforming to Specification PPP-C-843 should be of the water resistant type.

h. Dusting. Cushioning materials that are not dust producing should be used for packing items that are adversely affected by dust, unless a dustproof barrier is used to prevent dust from reaching the item.

i. Factors Influence Cushioning Selection and Use. Shock resulting from rough handling or dropping of shipping container is the usual cause of mechanical damage to the contents. The purpose of package or item cushioning is to reduce the intensity of the shock reaching the packed item to a level which the item can withstand. Factors influencing cushion design are the fragility and weight of the item, the load-bearing area of the cushion, the dynamic, force-deformation characteristics of the cushioning material, and the equivalent height of drop (usually 30 inches) for which protection is desired. Among these, the fragility and weight of the item are fixed values for any particular item. The load-bearing area of the cushion can be altered by suitable blocking or by packing the item in an inner container, if desired.

1-16. Application of Cushioning Materials

a. Concept of Cushioning. Cushioning is the protection from physical and mechanical damage afforded an item by means of compressible and resilient materials, known as cushioning materials, designed to absorb the energy of shocks and vibration caused by external forces. Details on "Package Cushioning Design" may be obtained in MIL-HDBK-304.

b. Functions of Cushioning. In order to utilize properly the many cushioning materials available in the military supply system, it is necessary to understand the functions of cushioning. Among these functions (fig 1-26) the more important are—

(1) *Controls movement and prevents damage caused by vibration.* Cushioning, when properly applied, controls the movement of the item within the barrier or container and dampens vibration.

(2) *Protect fragile or delicate components.* When fragile or delicate components form a part of an otherwise rugged item, they may be disassembled and packaged separately. If disassembly is not permitted and they must be left in place, cushioning is applied to give them protection.

(3) *Prevent rupture of barriers and containers.* Many items have sharp corners or projections which could puncture the barriers or containers in

which they are packaged, resulting in the entry of moisture or water. Cushioning is applied to these projections or corners to insure that waterproof or water-vaporproof barriers are not rendered useless by such damage.

(4) *Distribute forces.* Cushioning materials reduce the shock to an item by distributing forces over a large area, thus lowering the stress concentration at any one point on the surface of the item.

(5) *Prevent abrasion.* Items with highly finished surfaces which may be marred by blocking, strapping, contact with container surfaces, or contact with other items in the container, must be protected against abrasion by cushioning. Usually, lesser amounts and thickness of cushioning materials are employed to accomplish this cushioning function.

(6) *Absorb shocks.* Perhaps the most frequent and important use of cushioning is to absorb the energy resulting when an impact shock strikes a container. This shock energy is absorbed as the cushioning material is compressed by the impact.

(7) *Multipurpose cushioning.* The foregoing functions of cushioning should not be considered separately because cushioning is often used for more than one purpose in the same package. Material selected to protect an item against shock may at the same time minimize movement, prevent abrasion, protect barriers, and cover sharp projections. Many cushioning materials also act as good insulation to protect items against drastic temperature changes. Cushioning may be required to absorb liquids and consequently must have liquid-absorbing qualities to prevent liquid flow in case of breakage of the containers.

c. Requirements for the Use of Cushioning Materials. In addition to the requirements established in cushioning specifications in regard to material quality, construction, and performance, other important requirements must be met when cushioning materials are used within waterproof or water-vaporproof barriers. Sound packaging design practices dictate placing only the minimal required amount of cushioning material within water-vaporproof barriers, thereby minimizing the barrier area and the desiccant requirements. In addition, Specification MIL-P-116 requires that—

(1) Cushioning be as dry as practicable.

(2) Cushioning in contact with bare metal surfaces shall be capable of meeting Test Method 3005 of Federal Test Method Standard 101.

(3) If the item is coated with a preservative, the preserved item must first be wrapped in a

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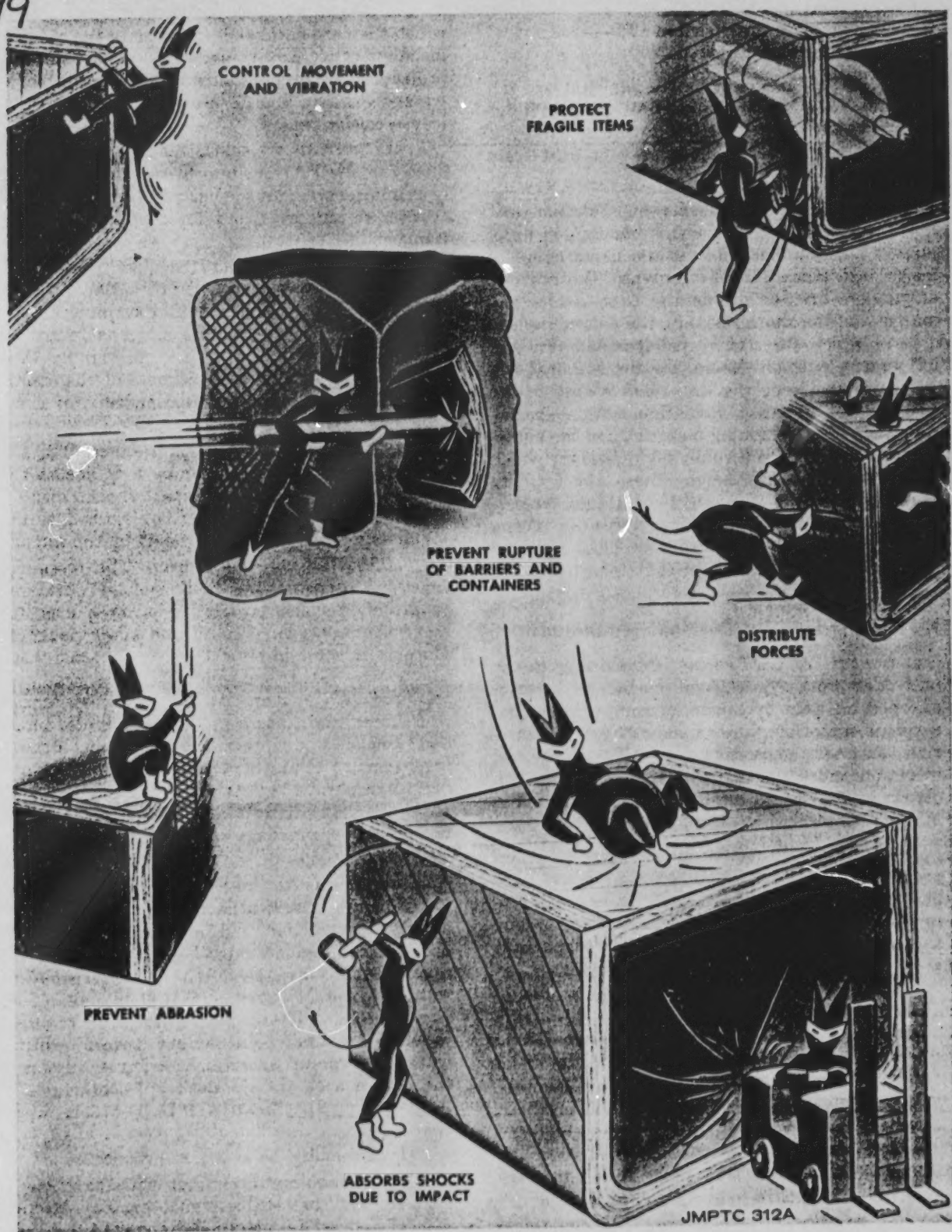


Figure 1-26. Functions of cushioning.

barrier conforming to MIL-B-121, Grade A, QQ-A-1876, or MIL-B-22191, Type I or II, before applying the cushioning material.

d. Cushioning Selection Factors. There are several factors that must be considered in selecting the appropriate cushioning material for a given application. The nature and physical limitations of the item, the favorable and unfavorable characteristics of the cushioning material, the destination of the packages, and the means of transportation must all be taken into consideration before an item can be properly cushioned.

(1) *Nature of the item.* In planning to cushion an item, the nature and physical limitations of the item must first be considered. The shock resistance, size, weight, shape, surface finish, and the degree of disassembly permitted will influence the way an item is to be cushioned (fig 1-27).

(a) *Shock resistance or fragility.* Fragility may be observed, but cannot be measured accurately by eye. The tendency is to overcushion seemingly fragile items and to undercushion seemingly sturdy items. Fragility—the greatest amount of dynamic force an item can withstand without destruction—can be measured with scientific instruments. The term “G-factor” has been accepted as indicating the shock resistance of an item. This resistance is determined by measuring the peak acceleration (deceleration) an item will withstand during impact and dividing this acceleration value by the acceleration due to gravity (32.16ft/sec/sec). This is expressed as—

$$\text{G-factor} = \frac{\text{Acceleration of the Item}}{\text{Acceleration due to Gravity}}$$

The G-factor values of many military items are being determined. In the absence of known G-factor values, the selection of cushioning must be based on experience with previous shipments and testing of similar items, or by assuming a G-factor for drop test purposes.

(b) *Size.* A large item may require a thinner layer of cushioning than a smaller item of the same weight because there is less load per square inch applied to the cushioning. This should be kept in mind when an item is irregular in shape—more cushioning may be required at the small end than at the large end.

(c) *Weight.* Weight in motion results in force, and force can cause damage. Thus, the weight of an item controls the thickness, quantity, and firmness of the cushioning material to be used. Generally, the heavier the item, the firmer the cushioning must be.

(d) *Shape.* A regular-shaped item will ordi-

narily fit snugly into a container with a minimum of cushioning, while an irregular-shaped one may require a complicated arrangement of pads and cells or foamed-in-place cushioning to bring it to a more regular shape. Light, small items which are irregular in shape can be made regular and at the same time positioned and held in the container merely by a wrap of cushioning material. Large, irregular items may make it impractical to use cushioning materials to make them regular. Blocking and bracing will have to be employed to adequately protect such items.

(e) *Surface finish.* An otherwise sturdy item may have highly finished surfaces which could be damaged by the rubbing action of harsh abrasive cushioning material, or the surfaces may be corroded and pitted by chemical action due to the presence of moisture and acidic or basic elements in the cushioning material.

(f) *Disassembly.* The disassembly of a highly irregular item may allow a reduction in its cube and permit simpler cushioning to give the necessary protection. Before disassembly, however, competent advice should be obtained as to the feasibility of reassembly and calibration, if necessary, in the field.

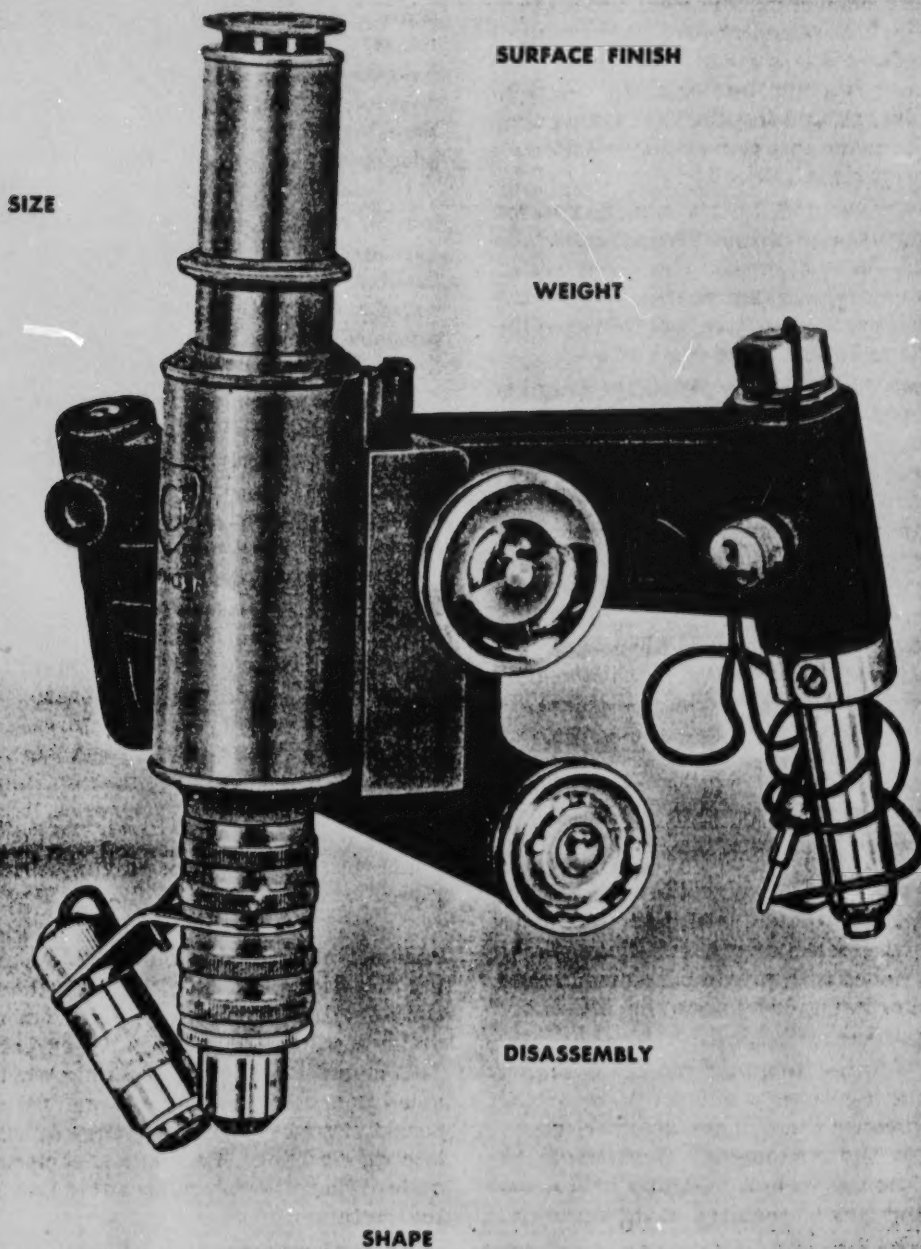
(2) *Characteristics of cushioning materials.* The chemical and physical properties of cushioning materials are many and may display both desirable and undesirable characteristics. These characteristics vary in importance for different applications. What might be a highly desirable characteristic in one application, may be detrimental in another. For instance, high moisture absorbency is required for packaging liquids, but is not desirable when packaging corrodible metal items.

(a) *Compression set* (fig 1-28) is the difference between the original thickness of a cushioning material and the thickness of the same material after having been released from compression under a standard load for a given period of time. This is important in determining whether a cushioned item can remain in storage for an extended period of time without causing the cushioning to lose its resiliency. Permanent compression set is undesirable when it creates free-moving space in the container.

(b) *Resilience* (fig 1-28) is the ability of a material to absorb a series of shocks and return to its original shape and thickness after each shock. Few materials are completely resilient and this quality is often greatly altered by changes in temperature. Rubber, for instance, is highly resilient in temperate zones, but loses its resilience under extreme climatic conditions.

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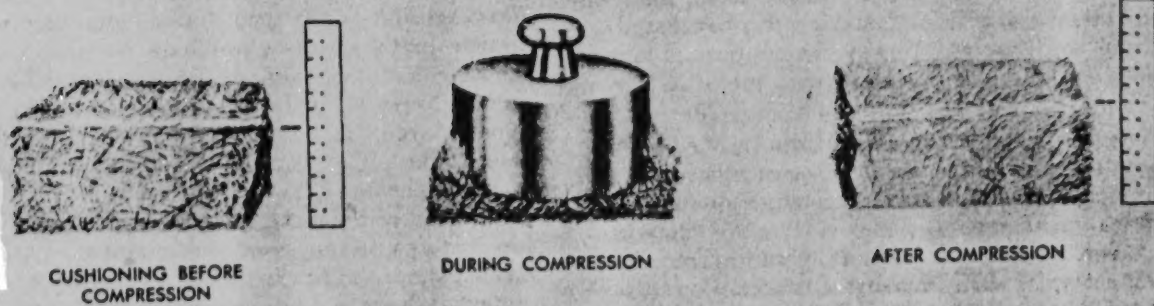
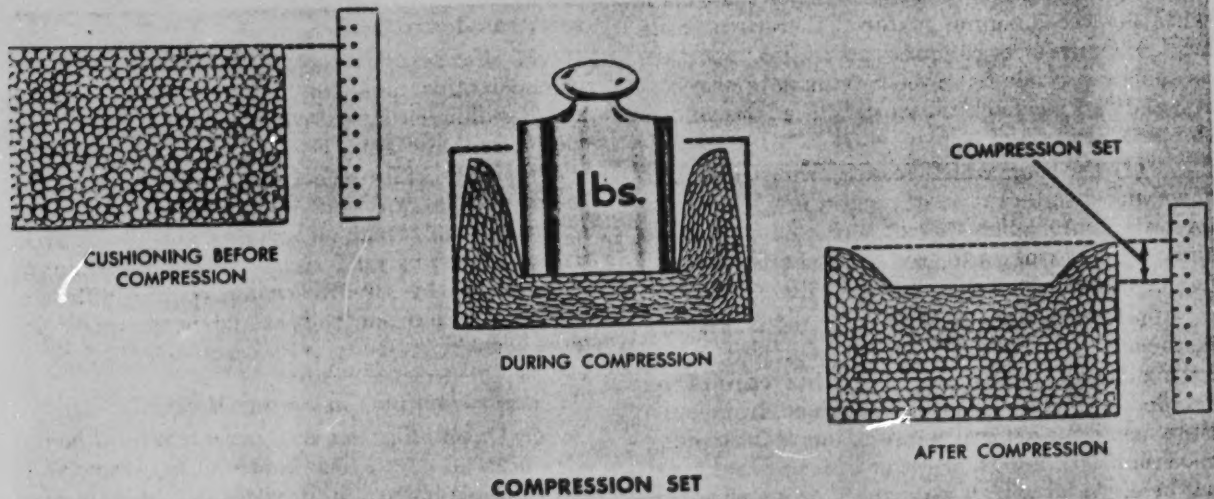
SHOCK RESISTANCE



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Figure 1-27. Item characteristics which determine the selection of cushioning materials.

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RESILIENCE



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Figure 1-28. Characteristics of cushioning materials—compression set, resilience and rate of recovery.

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(c) Rate of recovery (fig 1-28), or the time it takes for a cushioning material to return to its original shape after compression, is also important as some materials have too rapid a rate of recovery and "spring back" so quickly that damage to the item may result.

(d) Dusting, which results from the breakdown and disintegration of certain materials used for cushioning, allows small particles to become detached and work into crevices and critical working surfaces of the cushioned item (fig 1-29).

(e) The corrosive effect of some cushioning materials is undesirable when packaging items with critical surfaces. When this cannot be avoided, the item must be shielded from such materials by a neutral wrap or liner. Cushioning materials with a high acidic or basic content must not be enclosed within waterproof or water-vapor-proof barriers (fig 1-29). When cushioning material contains natural hair, it shall be treated with insecticide to prevent carpet beetle infestation.

(f) Fungus resistance of some materials is low and allows for the growth of mold, mildew, and other fungi. Many materials can be treated to inhibit such growth. However, such treated materials are often very corrosive to metal surfaces and must be isolated from them (fig 1-29).

(g) The abrasive characteristics of some materials are factors which must be considered when protecting precision surfaces such as the lenses of optical instruments. Some cushioning materials are soft-textured and generally can be placed in contact with easily marred surfaces. Coarse-textured materials should not be used on such surfaces (fig 1-30).

(h) Low temperature performance of certain cushioning materials makes them suitable for use in high altitude transport and in shipments to cold regions because they remain relatively soft and resilient (fig 1-30).

(i) Other characteristics which should not be neglected in choosing cushioning materials are fire resistance or flammability (fig 1-30), and the possibility of the material causing skin irritation to personnel who come in contact with it.

(3) *Destination of the item.* The destination of the item is a factor in cushioning. Many cushioning materials change their characteristics under extreme climatic conditions. Some materials become so rigid or brittle at extremely low temperatures as to make them useless as cushioning materials. In tropical climates, some materials soften and lose their cushioning qualities. In jungles or rainy locations, some materials will pick up excessive moisture which will result in the loss of

resilience and will lead to growth of fungus and accelerated corrosion.

(4) *Means of transportation.* The means of transportation must not be overlooked. Hazards and handling situations vary greatly between air, motor, rail, and ship. For example, there may be considerable difference between the amount of handling that an item being transhipped from truck, to rail, to ship would get and one that is being shipped by air freight. Likewise, an item to be delivered by air drop would require different protection from one that would be delivered by truck.

e. Representative Cushioning Materials.

(1) *Cushioning material, uncompressed bound fiber (PPP-C-1120).* This material may consist of any suitable natural hair, vegetable fiber, or synthetic fiber bound with an elastic material. Horsehair, sisal, and cactus fibers sprayed with latex are examples. It is furnished in four types and two classes. Type I is soft, Type II is medium soft, Type III, is medium firm, and Type IV is firm. When specified, each type shall be identified with a color matching as closely as possible colors shown in Federal Standard 595, as follows: Type I, brown; Type II, yellow; Type III, orange; and Type IV, red. Class A is water resistant with a natural hair filler bound with a suitable elastomeric binder and Class B, a common class, is not necessarily water resistant. This material may be supplied as uncompressed sheets and rolls and in molded shapes to fit the contours of the item. The materials have a high degree of resilience, low compression set, fair damping quality, and do not disintegrate easily. They are neutral and have a low water-soluble acidity so that their corrosive effects are slight. Moisture content and moisture absorption are both low; however, the materials may need to be treated for fungus resistance. Their performance is good at low temperature. They are intended to protect items against vibrational and impact shocks where resilient and water-resistant cushions are required.

(2) *Cellulosic cushioning material (PPP-C-843).* This material may be made of any kind of cellulosic matter which will result in a product meeting specification requirements. The cellulosic matter used may be cotton, bonded fibers, natural fibers, or creped wadding. The material is furnished in two types—Type I, water absorbent, and Type II, water-resistant. It is available in two classes—Class A, low tensile strength, and Class B, high tensile strength. The Type II material is required to be noncorrosive. It has no corrosive effects as long as it is kept dry. However, even

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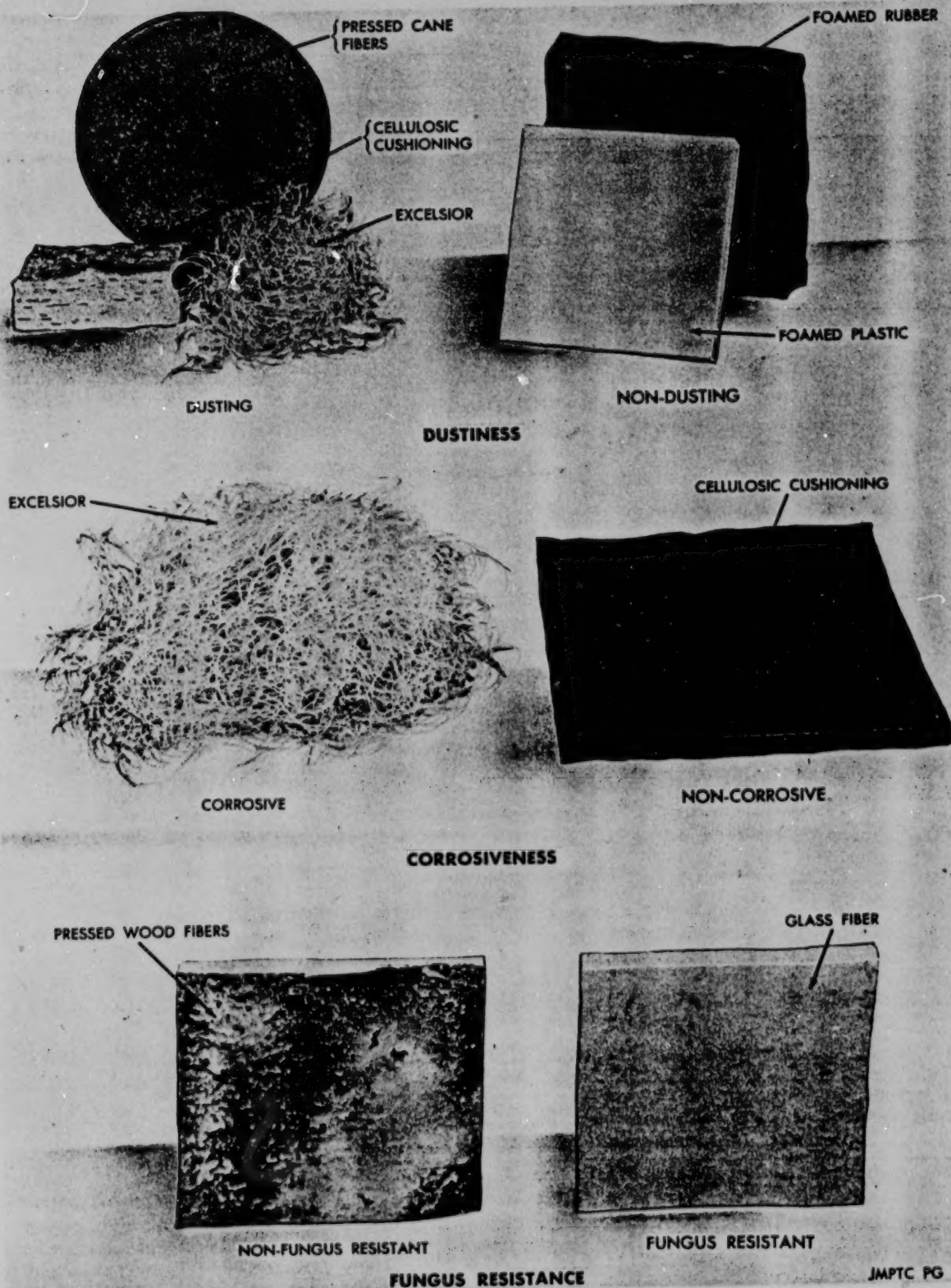


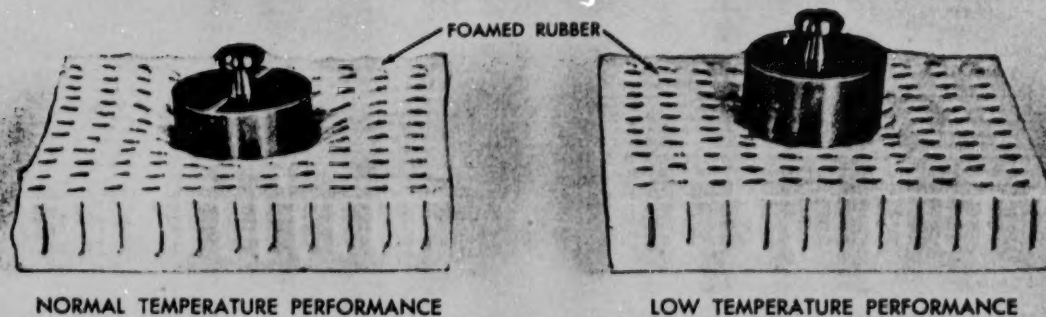
Figure 1-29. Characteristics of cushioning materials—dustiness, corrosiveness and fungus resistance.

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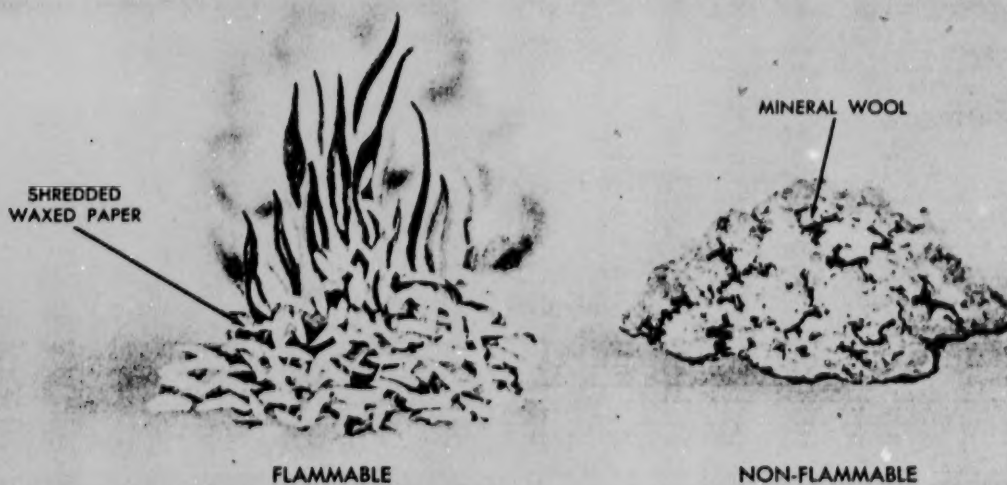
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ABRASIVENESS



TEMPERATURE PERFORMANCE



FLAMMABILITY

JMPTC PG 193

Figure 1-30. Characteristics of cushioning materials—abrasiveness, temperature performance and flammability.

when it is water-resistant, water may be absorbed and retained within its pores. Cellulosic cushioning material is readily moldable and fairly resilient. Its compression set is high, its damping ability excellent, but dusting is great enough to require an excluding wrap around items susceptible to dust damage. Its performance in cold temperature is good. This material is intended for use in packaging lightweight, fragile items; as a protection against abrasion; and Type I, specifically, for absorbing liquids from containers broken in transit.

(3) *Fibrous glass cushioning material (MIL-C-17435)*. This material consists of glass fibers matted, bonded, or otherwise treated to meet specification requirements. The surface of Type II material is coated with an elastomeric material to prevent dusting. This material can be supplied in various classes of density ranging from a very soft material with a load range from 0.5 to 3.0 pounds per square inch to a very firm material with a load range from 50 to 120 pounds per square inch. The resilience of the material is high, its compression set low, its damping fair, and its dusting slight, especially in the Type II material. It is highly flame-resistant and water-resistant. The material is neutral and will produce no corrosive effects. Moisture content and moisture absorbency qualities are low. The material is fungus resistant and performs well at low temperatures. Fibrous glass cushioning is intended for use in protecting packaged or installed equipment against shock and vibration. A temporary skin irritation may occur as a result of handling the uncoated type (Type I). Minute fibers sticking to the skin are readily removed by ordinary washing. Suitable precautions and adequate ventilation should be used when there is any possibility of particles getting into the eyes or of accumulation of glass dust in the air.

(4) *Paper honeycomb cushioning material (MIL-H-9884)*. This material consists of unbleached kraft fibers constructed into slice increments by lamination of sheets of paper board with a weatherproof adhesive. This material is primarily used as an energy dissipating medium for landing shock to which air dropped objects are subjected. It may also be used for special packaging requirements. The material is not recoverable because it is crushed upon impact.

(5) *Wood excelsior in fabricated pads and bulk form (PPP-E-911)*. Excelsior is made of shredded, straight-grained soft wood, free from mold, decay, and pitchy accumulations. It is furnished as bulk excelsior or as pads. The pads may be either waterproof or nonwaterproof. The bulk excelsior is

obtainable in six grades, from superfine wood wool to coarse or ribbon excelsior. The pads are obtainable in five weights, from light to extra heavy. The material has a high compression set, medium resilience, and excellent damping qualities. Its moisture content and absorbency are high and the corrosive effects are considerable because of the wood acids present. It has poor fungus resistance, is highly flammable, and has poor low temperature performance. Its dusting characteristics are high and if the moisture content gets too low the material disintegrates into fine particles. It is abrasive and should not be used against finished surfaces which may be marred by scratching. Excelsior is best used for packaging in the waterproof pad form or as a cushioning layer between the walls of an inner and an outer container, with a waterproof liner to keep out excess moisture. The finer grades of excelsior are for cushioning the lighter, more fragile items, and the coarser grades are best adapted for cushioning rugged items.

(6) *Hair felt (C-F-202)*. Hair felt consists of cleaned, washed and sterilized cattle hair. It is finished in five types based on the fabrication process. It is available in rolls of 3, 6, or 9 feet in width. It is also available in a variety of thicknesses and densities. It has an average degree of resilience, low compression set, poor damping, and some amount of dusting. It will withstand repeated compression and abrasion without disintegrating. The felt must be free from acids. It will retain moisture and is subject to fungus attacks unless treated. It is used mainly as cushioning and padding of cradles for large articles. It should be glued in place and kept dry.

(7) *Solid and corrugated fiberboard (MIL-B-3106 and PPP-F-320)*. Both solid and corrugated fiberboard are used in cushioning, but corrugated is more frequently used because it has greater cushioning value. The most common forms of fiberboard applications are die-cuts, open end cells trays, pleated pads, and flat pads (fig 1-31). Generally, cells and trays should be held in shape with tape. Those surfaces of the cell or tray which are perpendicular to the contacting surface of the item are called bracing supports and are the load-bearing members. To utilize all of the strength of these bracing supports, they should bear directly on the item. Pleated pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than on bracing supports. Therefore, they should be used to cushion heavier loads (up to 2 pounds per square inch). Flat pads are used to block shallow projections, to level off projecting screw heads,

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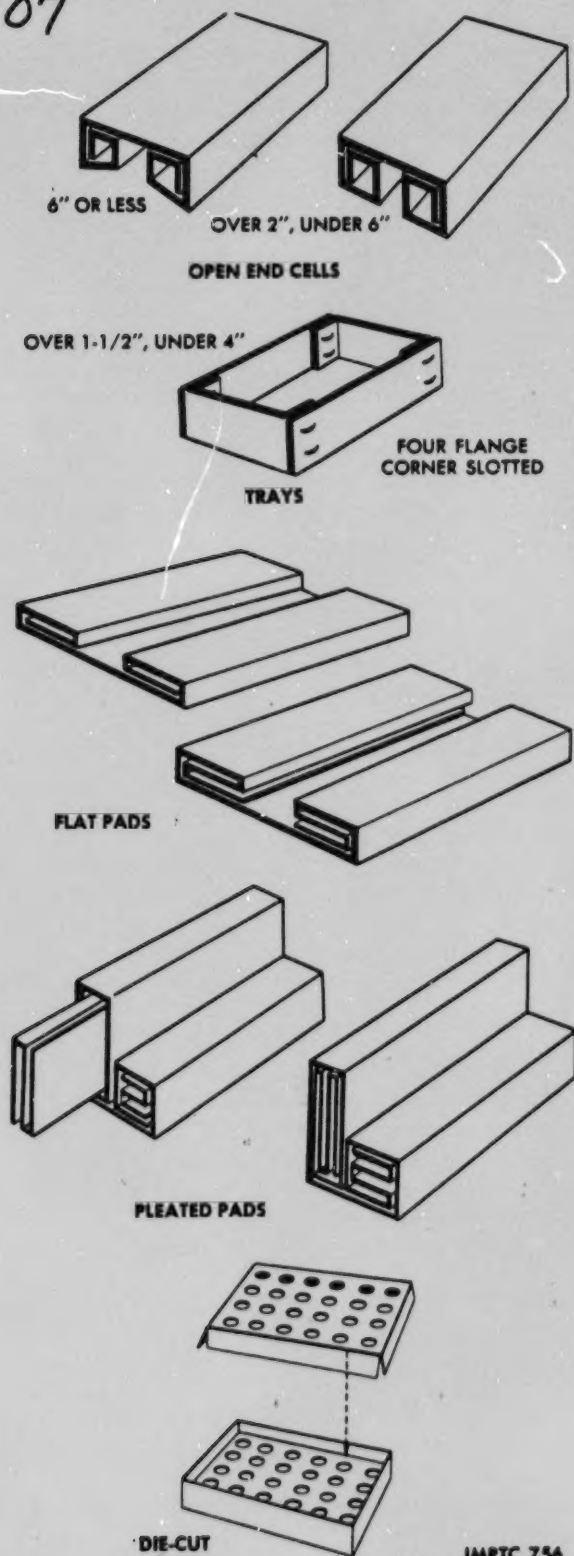


Figure 1-31. Examples of fiberboard die-cuts, open end cells, trays and pads.

and to separate items within a container. They can be slotted to form partitions, or may be die-cut or punched to fit articles or irregular shape. Application of fiberboard cells, trays, and pads is illustrated in figure 1-32.

(8) *Unicellular polypropylene foam (PPP-C-1797)*. This material is a low density, resilient, unicellular (closed cell) polypropylene foam material for use in cushioning and packing applications in the form of thin sheets. It is useful throughout a temperature range from -65°F to 160°F . It is intended for use as a protective cushioned wrap for low density items. The foam can be laminated to a wide range of products including paper, paperboard, and may be used for the protection of surfaces from abrasion. Typical packaging application/s is surface protection for optical lenses, equipment with critical surfaces, electrical and electronic equipment, glassware, ceramics, and magnetic tape rolls. When stored in closed containers it produces no trapped volatiles which could cause fire or explosions. Polypropylene, by its nature, is unaffected by most exposures to grease water and most acids, bases and solvents. It contains no plasticizers, solvents, or lubricants.

(9) *Expanded polystyrene (PPP-C-850)*. This resilient cushioning material consists of expanded polymers or copolymers of styrene for use in packaging applications. It is furnished in two types. Type I is in sheet form and Type II is in roll form. Both types come in four classes and two grades. Class 1 is soft, Class 2—medium, class 3—firm, class 4—extra firm. Grade SE is self-extinguishing. This cushioning material is used within packages to protect items from damage due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning. It can also be used to provide temperature insulation or when cushioning material must perform at extremely low temperature.

(10) *Cushioning, wrapping paperboard (PPP-P-291)*. This is a paperboard composed of a corrugated sheet or a solid molded pulp sheet firmly cemented to a backing flat sheet of unbleached sulfate fiber paper. The paperboard is furnished in three types—light, medium, and heavy-duty, and in two classes. Class 1 material is flexible in all directions and Class 2 material is flexible in one direction. It is furnished in sheets or rolls, as desired. The corrugations of Class 1 material are indented to permit the material to be folded in any direction and in any shape. This material has high compression, low resilience, excellent damp-

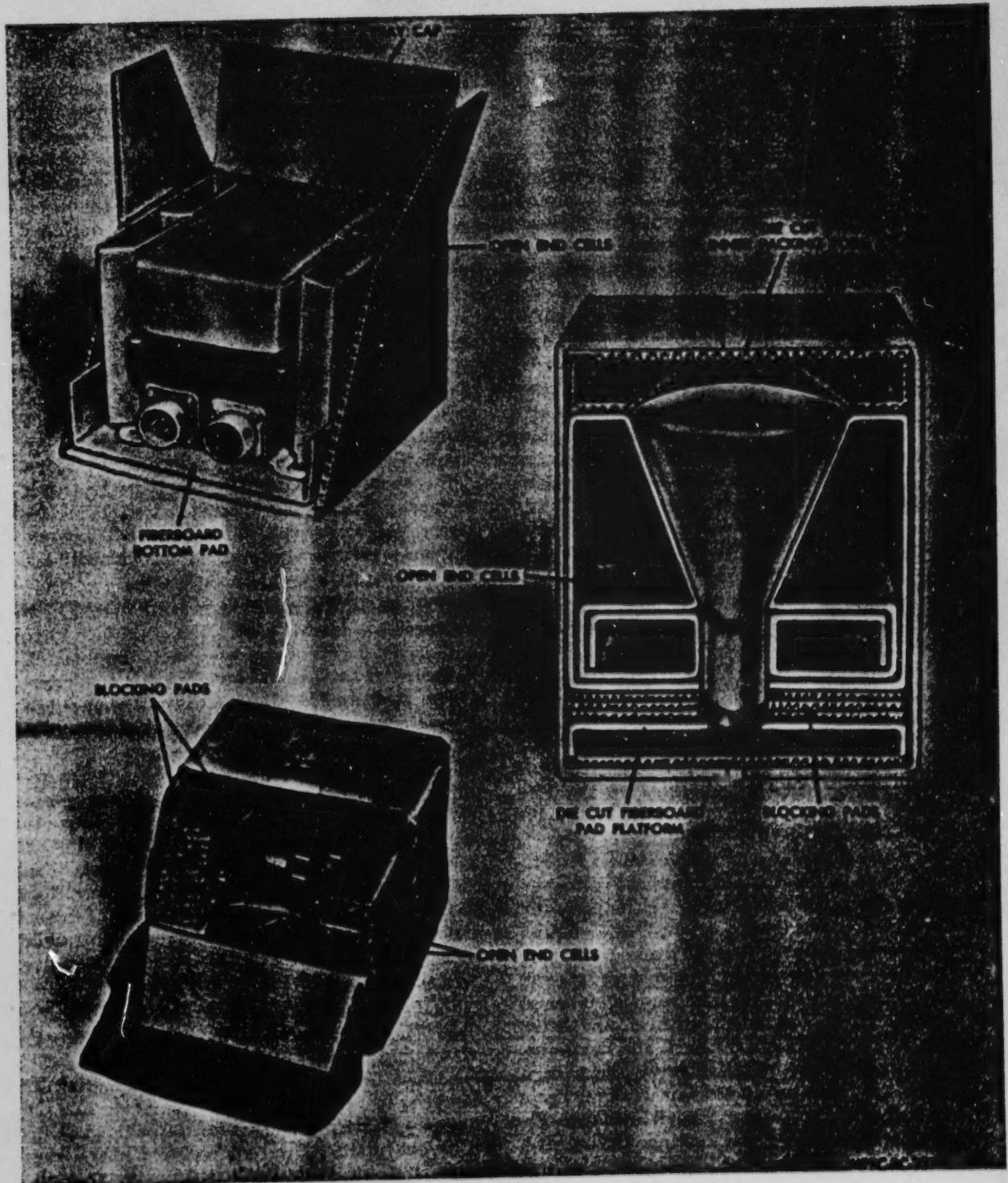


Figure 1-32. Application of Fiberboard die-cuts, open end cells, trays and pads.

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ing, and some dusting. The moisture content and moisture absorption are high. The material is not neutral and hence has a high corrosion effect. Its performance in cold weather is poor, and it is neither fungus nor flame-resistant. Class 1 paperboard may be used to wrap irregular objects without cracking. Critical metal items must first be wrapped in a chemically neutral or greaseproof barrier. Class 2 paperboard is suitable for use in roll form, as a bottle wrap, or as box partitions.

(11) *Rigid or flexible polyurethane foam (MIL-P-26514)*. This material consists of both rigid and elastic types of foamed products obtained through the proper blending of complex synthetic chemical compounds. By proper combinations, reaction mixtures can be poured or pumped into various shaped cavities. Carbon dioxide is given off by the reactions, causing the rapidly stiffening resin to expand, completely filling the space. The material then sets rapidly to a lightweight, solid, porous structure that has excellent cushioning properties. The material is furnished in a form suitable for foaming-in-place application or it may be preformed and supplied in rolls, flats, sheets, or molded shapes. Strong rigid foams, tough elastic foams, soft flexible foams, and spongy water-absorbent foams can be obtained by the choice of ingredients. Foams with densities as low as .5 pounds per cubic foot may be obtained. These foams can be adjusted to give a high or low compression set, excellent or poor damping, and high or low resilience. In other words, the material can be tailor-made to meet the requirements of any type of cushioning required. There is no dusting problem, moisture content is exceedingly low, absorption capacity can be varied, and the corrosive effect is negligible. The material is flame- and fungus-resistant, and it performs well in cold climates. (See MIL-HDBK-768(SM) for details on rigid polyurethane foam.)

(12) *Latex foam sponge rubbers*. These materials are made by incorporating into the rubber an inflating agent, such as baking soda, that gives off a gas which expands the mass during the vulcanization process. The rubber is made from slab rubber into sheets, strips, molded or special shapes. These materials may be supplied in cored or uncured types; soft, medium, firm, and extra firm classes; and in flame-resistant and nonflame-resistant grades. The materials have a very high resilience, low compression set, fair damping properties, high moisture content, high moisture absorption; and produce some dusting. If kept dry, the corrosive effects are slight. Their low temperature performance is poor. The materials have a high density and are expensive to use. The molded

forms are often used in conjunction with reusable containers and the initial cost is reduced by the amount of reuse obtained.

(13) *Chemically blown cellular rubber (MIL-R-6130)*. Type I, open cell, is made by incorporating into the rubber compound a blowing agent, such as sodium bicarbonate, that gives off a gas which expands the rubber during vulcanization to provide a mass having open and interconnecting cells. Type II, closed cell, is made by subjecting a rubber compound to a gas, such as nitrogen, under high pressure. It may also be made by incorporating gas-forming materials in the compound. When the pressure is lowered during vulcanization, the mass expands, and Type II becomes a myriad of individual, nonconnected, gas-tight cells. These materials may be obtained in soft, medium, and firm classes; oil- and flame-resistant, and nonoil-resistant grades. These materials are furnished in sheets or specially molded shapes, as required. The materials have a high resilience, low compression set, fair damping, little dusting, slight corrosive effect and poor-to-average low temperature performance. The major differences in properties of Types I and II are that, because of its closed cell construction, Type II will absorb less water than Type I and will expand at the low pressures encountered at high altitudes.

(14) *Plastic film, heat sealable, flexible, cellular, PPP-C-795*. This material is constructed of two composite sheets of plastic film, one face having uniformly distributed closed cells (bubbles), the other a flat surface. It is available in two classes; Class 1—transparent, and Class 2—opaque, for use in cushioning for packaging applications. Material is furnished with various cell sizes (air bubbles). It is intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, corrosion, contamination, and abrasion during handling and shipment and is especially suitable for use as inserts within transparent bags. The use of Class 1 material, due to its transparency, permits inspection of the contents without opening the package. The flexibility of the material permits it to be used as pads, bags, wraps, dunnage, or as a filler.

(15) *Tubular, cellulosic, treated free flow, MIL-C-23734*. This material is free flow cushioning and void filling made of resilient, hollow, treated cellulosic tubes. It is noncorrosive and nondusting. The material is used for package cushioning and dunnage applications where a bulk, free flowing, noncorrosive material is required to protect fragile items from damaging effects of shock and vibration incurred during shipment and handling. It may be reused if it is not damaged beyond perma-

ment deformation. Containers should be filled with an excess of 7 percent to provide optimum degree of protection. Items having voids where the material can be entrapped should be wrapped in a non-corrosive barrier material. Material should not be used for cushioning when the item being packaged exerts a bearing load exceeding 1 psi.

f. Methods of Cushioning. Cushioning is generally accomplished by one of the following methods:

(1) *Floated item.* The item is floated in cushioning material and placed within a unit container (fig 1-33). This is perhaps the method most commonly used for cushioning small, lightweight, fragile items against shock, vibration, and abrasion. It is in this case that the requirements of MIL-P-116 concerning dryness and noncorrosiveness of cushioning materials are most important since both the item and the cushioning material will be inclosed in the unit container. Cushioning materials in direct contact with metal surfaces shall meet the requirements of MIL-P-116. The accepted practice today, when the requirements of MIL-P-116 have been met, is to make the cushioning the first wrap. Greaseproof barriers are required if the item is preserved. Cushioning materials must be secured about the item. Loose cushioning may result in either the displacement of the material when the package is subjected to shock, its disintegration under repeated vibration, or the production of dust or loose particles which will be entrapped within the package. Since a container may be dropped on any one of its faces, edges, or corners, the cushioning material must be designed to withstand the full impact of the entire weight of the item in any direction.

(2) *Floated package.* The item is packaged in an interior container which in turn is floated in cushioning material (fig 1-33). This method is generally used in connection with semifragile items of medium size and weight. The item is initially packaged (which may include cushioning or blocking) in an interior container, then floated in cushioning and placed into an exterior container. In this method, the noncorrosiveness and moisture content of the cushioning materials are not critical since the materials will not come in contact with the item. The use of absorbent cushioning materials, when used in this method, should be governed as follows:

(a) When both the interior and exterior containers are water-resistant, the cushioning material may be simply placed between the two containers.

(b) When either container is nonwater resistant, the cushioning material must be placed in

the form of pads wrapped in a water-resistant barrier material.

(c) An alternative for the second case ((b) above) is to provide the interior container with a sealed water-resistant wrap and the exterior container with a sealed line. The cushioning material is then placed between the two barriers.

(3) *Shock mounts.* The item is cushioned by means of shock mounts (fig 1-33). This method is used to cushion fragile items and sensitive instruments or mechanisms that can be damaged by shock and vibration. The weight and size of the item may vary from light and small to heavy and large. The shock mounts may consist of elastomeric springs or rubber blocks. This method of cushioning may be accomplished in four main ways.

(a) The item may be suspended directly by means of elastomeric springs.

(b) The item may be blocked in a cradle and the cradle suspended by means of elastomeric springs.

(c) The item may be boxed in an intermediate container and the intermediate container suspended by means of elastomeric springs.

(d) The item may be boxed in an intermediate container and the intermediate suspended by means of rubber shock mounts.

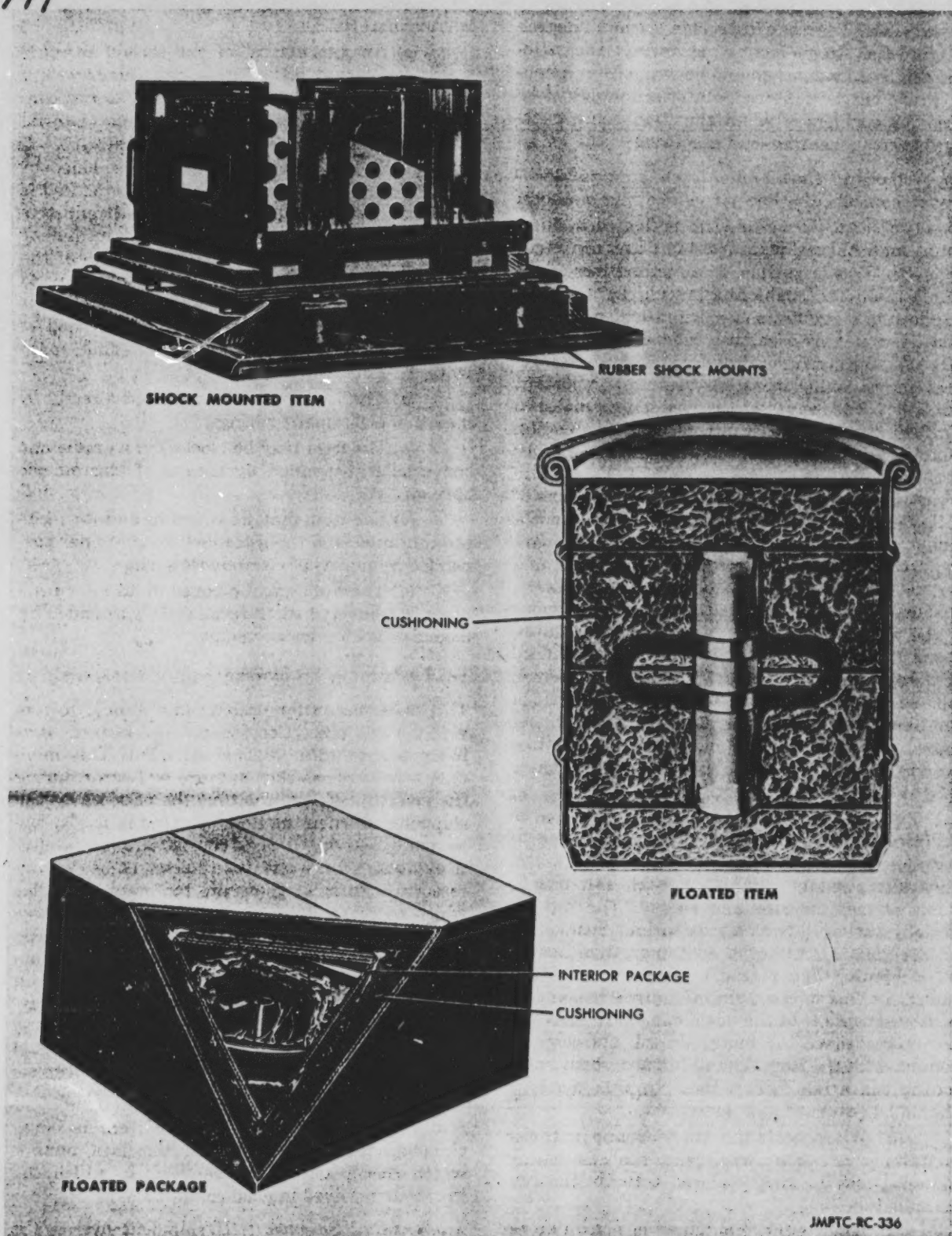
1-17. Packing Problems

The basic reason for packing any item is to provide enough protection against the hazards it is likely to encounter during shipment. This minimizes the chances that damage will occur during the interval between the time the pack leaves the shipper and when the item is placed in use by the receiving activity. It is, of course, an impossibility to evaluate all the hazards that might be encountered in transit, as there are too many variables which can affect the condition in which an item may be found upon arrival at its destination. The guidelines to packing presented herein have indicated the principles and practices that have been found satisfactory in giving protection under average handling and storage conditions. If the solution of specific packing problem is not located in this section, the following procedures are recommended for shipment from depots:

a. Domestic Shipments. If an item is being shipped domestically, pack the item in a manner which closely duplicates the pack in which the item was received in good condition.

b. Oversea Shipments. If shipment overseas is involved, and no previous history of a container in

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JMPTC-RC-336

Figure 1-33. Methods of cushioning.

which the item had been shipped to a similar destination is available, construct a pack embodying as many as possible of the principles outlined in this section. This pack should be prepared exactly as it would be shipped including complete preservation and interior packing. It is then tested by subjecting it to the applicable performance tests described in paragraph 1-24. The tests are based upon the size as well as the gross weight of the container since both influence the amount of rough handling the container will receive. Small, light packages are easier to move than the larger and heavier packs and, consequently, they can be expected to receive a greater amount of handling. Performance tests are required for the primary purpose of determining the adequacy of all the operations entering into preparation of a pack. At the conclusion of the tests, performance is based on the condition of the container, its contents, the blocking and bracing, cushioning, preservation, and other packing materials. The pack should be examined for any damage, noting in particular any obviously weak points which might need to be strengthened. Usually the container, if constructed according to specifications, will withstand the rough handling. If, however, the container is damaged, a study should be made of the causes. Deficiencies in the blocking and bracing may result in damage to the container, in which case these deficiencies should be corrected. Other times the nature or shape of the item may cause the container to fail. Then, the container should be reinforced. In any event, when deficiencies become obvious, either in the containers, the contents, the blocking and bracing, cushioning, preservation, etc., the pack should be appropriately modified and the test repeated until no damage occurs which affects the utility of the pack.

1-18. Packing Small, Lightweight Items

As previously pointed out, cushioning materials are frequently employed to block lightweight items. Various methods to accomplish blocking with cushioning are described in paragraph 1-12. In some instances, however, cushioning materials such as fiberboard are primarily used for blocking. The effectiveness of fiberboard as blocking and bracing depends upon its strength and its resistance to moisture when not protected by suitable moisture barriers. The domestic class of fiberboards will rapidly absorb moisture with a resulting loss of strength. The weather-resistant class on the other hand, retains a greater proportion of its strength in the presence of moisture. Fiber-

board is most frequently employed as blocking in fiberboard containers because the items packed in them are usually small and lightweight and do not require heavier types of blocking. Also, the container manufacturers can provide and fabricate pads, cells, trays, or partitions of the same material at a low cost. Both solid and corrugated fiberboard are employed as blocking material, but the corrugated is used more frequently because it has greater cushioning value and because of its lower cost. Occasionally, a pack will contain a comparatively large void which will necessitate blocking to prevent shifting of the item. In such cases, a fiberboard carton may be used for blocking the item in place. The carton used for blocking should be closed and sealed, and must be strong enough to provide adequate strength in all directions.

1-19. Packing Large Items

Large items require special attention to adequately secure them within the container. Such items are anchored to the base of the container and blocked and braced into a secured position on the base. A clearance of at least 1 inch is provided between the end, side, and top panels and the item is seldom blocked and braced to these panels. Thus, the container must have a rigid base and the rest of it must be free to distort without placing stresses directly on the contents.

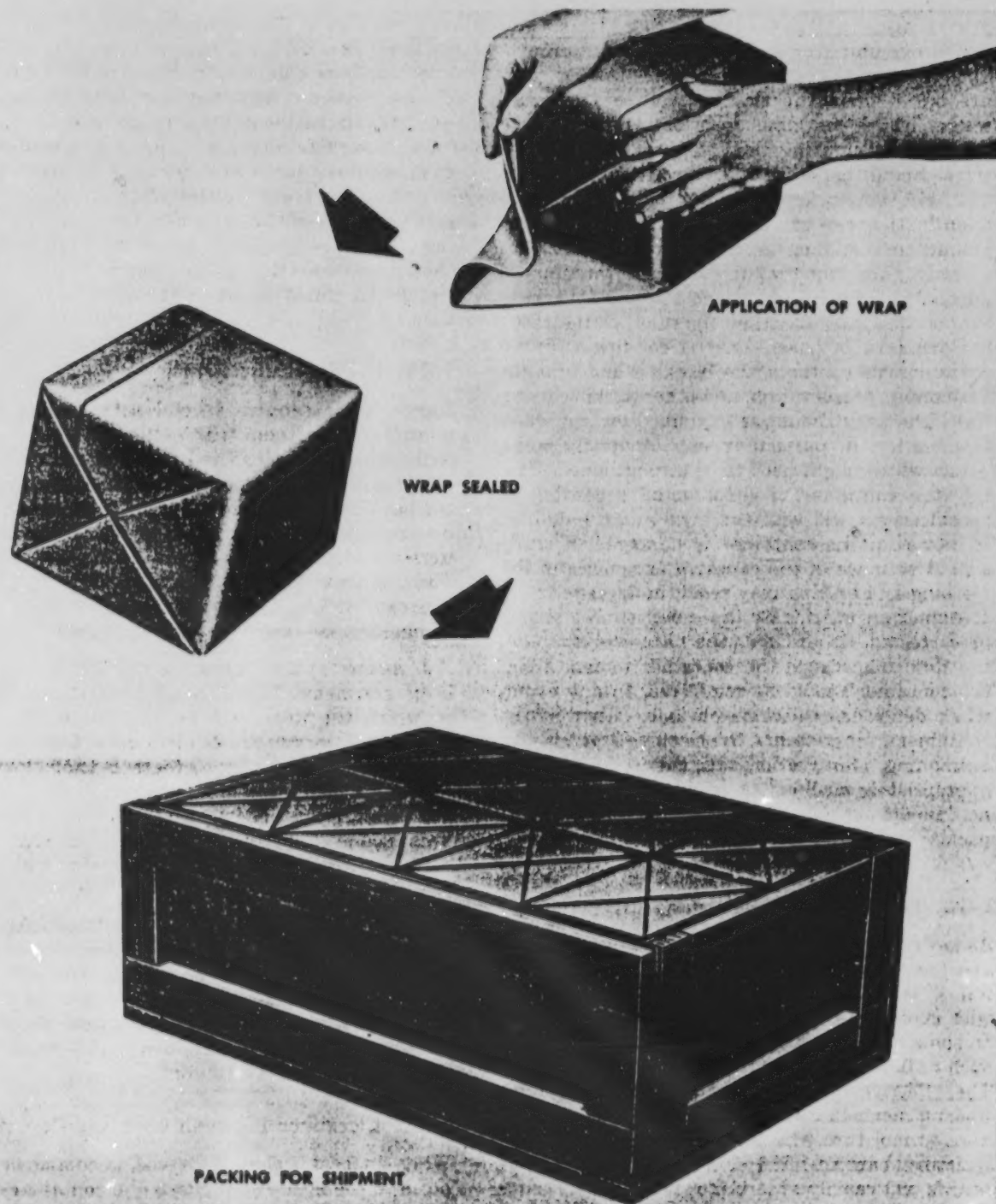
a. Anchoring to Base of Containers. Crates for large and heavy items should have sturdy bases to which the items can be adequately secured. Many ingenious methods have been developed to hold items to crate bases (para 6-1c(5)). For sill and skid type crates, it is essential that the load be carried primarily by the outside skids or sills. This means that loads that cannot be secured to the side sills or bases must be provided with load bearing members that transmit the load to them.

b. Blocking and Bracing a Large Item. After the item has been anchored to the base of the container to prevent its movement in a vertical direction, it is blocked and braced to prevent its movement in a horizontal direction. An item should be anchored only to the base, hence all bracing and blocking should be so secured.

1-20. Clearance Between Item and Container

When an item is blocked, braced, anchored, or tied down to the inside of one face of a container or to an auxiliary base which, in turn, is so secured, a clearance of not less than 1 inch should be provided between the item and all members of the

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Figure 1-34. Waterproofing of individual packages.

remaining faces of the container. A minimum clearance of 2 inches should be provided around fragile parts of the item that might be damaged due to slight distortion of the container. A minimum 2-inch clearance should be provided between items within floating bag barriers and adjacent members of the container.

1-21. Weatherproofing The Pack

At this point in the sequence of packing operations, it is assumed that a careful study has been made of the item to be packed; a suitable container has been selected; blocking, bracing, and cushioning has been designed; and the contents are ready to be placed into the container. The next step is to provide, when necessary, a protective barrier in the form of a case liner, crate liner, shroud, wrap, bale, or tarpaulin fabricated from one of several materials. The barriers are intended to prevent deterioration of the item, and the preservation and packing materials used to protect it, by excluding the entry of liquid water, by limiting the entrance of water-vapor, or by diverting water from the materials which are subject to water damage. In addition, barriers will afford protection from dust, dirt, and other foreign matter. Barriers designed to prevent the entry of liquid water (waterproof barriers) will not be used when the interior packs have been individually waterproofed as shown in figure 1-34, nor when the asphaltum in the barrier materials or sealants may prove injurious to the inclosed items. The water-vaporproof protection afforded by caseliners differs from that afforded by a Method II package in that water absorbing desiccant is not used with caseliners.

1-22. Weatherproofing (Case Liners, Wraps, and Shrouds)

Except as provided herein, weatherproof liners, wraps, shrouds or other suitable means shall be provided in shipping containers as necessary to shield the contents from the effects of water, water-vapor, dust, dirt, and other harmful matter. When a completely inclosed barrier is provided as in the case of liners and wraps, all seams should be completely and continuously sealed to offer protection equal to the barrier material itself. Barrier materials and sealants constructed with asphaltum shall not be used in the presence of mothproofing chemicals such as paradichlorobenzene and naphthalene. Barrier materials and sealants constructed of asphaltum shall not be used to protect items subject to stain or other damage

caused by asphalt unless such items are initially protected to exclude asphalt.

a. Types of Weatherproofing Barriers. The particular type of barrier to be used depends on the type of exterior container or the intended use of the barrier (table 1-11). In selecting the type of barrier to be used, consideration should be given to the following:

(1) Sealed case liners and sealed wraps are used to resist the passage of water and water-vapor. Fabrication of case liners is covered in b below.

(2) Sealed case liners will not be used in the packing of materiel unless specifically authorized.

(3) Crate liners and shrouds are used to shed water from the top and sides of the item, allowing free circulation of air. The application of crate liners is described in chapter 6 (fig 6-19). Shrouds are fabricated from water-proof barrier material conforming to Specification PPP-B-1055, Class E or heavier. The seams are sealed with water-resistant adhesive conforming to Specification MMM-A-260. Shrouds also may be made of material conforming to Specification L-P-378.

(4) It is important that shrouds be secured to prevent damage or loosening by storms. They should be weighted if necessary and arranged to avoid formation of water pockets. Shrouds should never extend entirely to the base of a crate or to the ground since the free circulation of air around the enclosed equipment is thereby prevented.

b. Case Liners, Overwraps, and Plastic Bags. Flexible waterproof or water-vaporproof case liners, overwrap sheets, and plastic bag liners should be fabricated and closed in accordance with Specification MIL-L-10547.

(1) They shall be furnished in the following types: Type I, high-top case liner (fig 1-35); Type II, double-top pad liner (fig 1-36); Type III, overwrap sheet, and Type IV, plastic bag. Type I case liners are most frequently used; Type II liners may be used when a level, rigid surface exists or when the depth of the case liner exceeds 36 inches. Type III overwrap sheets are barriers used around intermediate boxes. Type IV case liners are used in the same manner as Type I and II case liners.

(2) They are available also in six grades as follows: Grade A, water-vaporproof; Grade B waterproof, all temperature; Grade C, waterproof, asphalt-laminated kraft; Grade D, waterproof and greaseproof; Grade E, water-proof, grease-proof transparent, all temperature, and Grade F, waterproof, transparent, all temperature.

Table 1-11. Application of Weatherproof Barrier Materials for Packing

Use	Barrier Materials					
	L-P-378	PPP-B-1066	MIL-B-121	MIL-B-131	MIL-B-13239	MIL-B-22191
Case Liner		Classes H-2, H-3(a), H-4, H-5, L-2(b), and M-1 Waterproof	Types I and II, Grade A, Class 1 Waterproof	Classes 2 and 3 Water-vaporproof	Types B-1, CW-1, and CW-2 Waterproof	
Sealed Wraps and Plastic Bags	Type I Waterproof	Classes B-1, B-2, B-3, C-1, C-2(a), E-1, and E-2 Waterproof		Classes 1, 2 and 3 Water-vaporproof	Types B-1, B-2, B-3, CW-1, and CW-2 Waterproof	Types II or III Waterproof
Crate Liner		Classes C-2(a), E-1, E-2, H-5, L-2(b), and M-1 Watershed				
Shroud	Types I and II Watershed	Classes E-2, H-5, and M-1 Watershed				
Baling		Classes B-1, B-2, B-3, and E-2 Watershed			Type B-1 Watershed	
Temporary Tarpaulin -- Ammunition Containers	Types I Watershed	Class L-4 Watershed Class P-1				

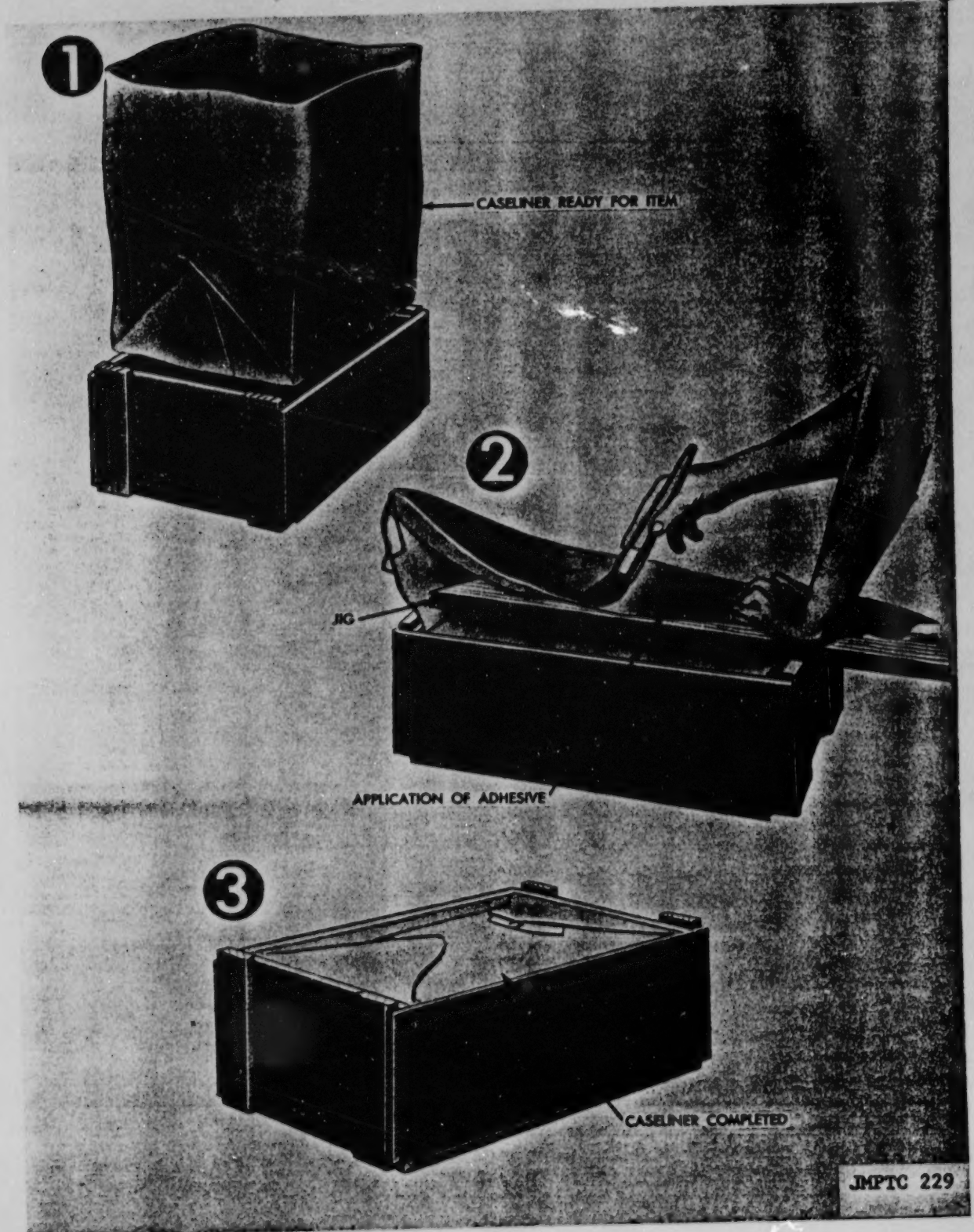


Figure 1-35. Using and closing a high top caseliner.

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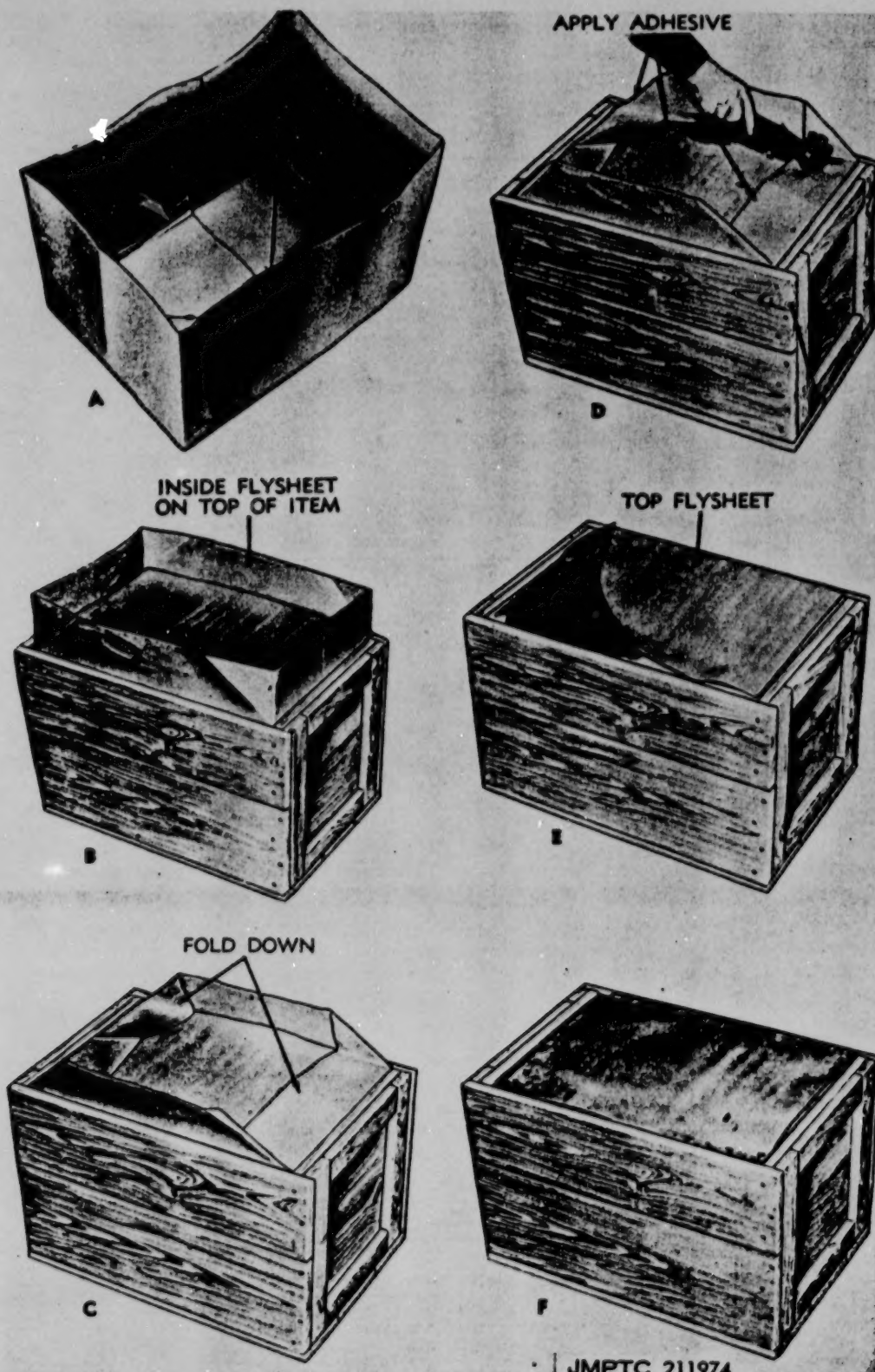


Figure 1-36. Double-pad closure flysheet.

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Table 1-12. Barrier Materials for Case Liners, Overwraps, and Plastic Bag Liners

Use	Liners, overwraps, and bag liner		Specification	Barrier materials
	Grade	Types		Classification
Subsistence item -----	C	I, II, III	PP-B-1055	Classes H-2 thru H-5, M-1
	F	IV	L-P-378	Type I
Nonsubsistence item -----	A	I, III	MIL-B-131	Classes 1, 2 and 3
	B	I, II, III	MIL-B-13239	Types B-1, CW-1, CW-2
	C	I, II, III	PPP-B-1055	Classes E-1, E-2, H-1 thru H-5, L-2, M-1
	D	I, II	MIL-B-121	Types I and II, grade A, class 1
	E	IV	MIL-B-22191	Type II

(3) Table 1-12 shows the barrier material to use depending on the type and grade of case liner, overwrap, or bag liner required and whether they are to be used for subsistence or nonsubsistence items.

(4) Case liners should be made large enough so that the weight of the load will be borne entirely by the container, not by the liner. There should be no tension in the walls or joints of the liner after it has been closed around the contents.

(5) Experience has shown that under some conditions, especially when the contents do not fill the case liner completely, waterproof case liners do more harm than good by trapping and holding water rather than preventing its entry. It is not essential that there be openings in the sealed liner for this to happen. If the liner material has low resistance to water-vapor transfer (a common occurrence) water can enter in the form of vapor and condense on items within the liner. That this can be largely a one-way process has been proven when, at the end of an extended outdoor exposure period, sealed case liners have been opened and found partially filled with liquid water. When packed items need protection against water, it is preferable to incorporate the protection in the individual unit packages in lieu of using case liners.

c. Linings for Drums, Kegs, Barrels, and Bags. Linings should be provided for drums, kegs, barrels, or bags when their contents require protection not otherwise provided by the containers against sifting, contamination, or free water. The lining material should conform to Specification PPP-B-1055, MIL-B-22191, or MIL-B-13239. Fabrication and closure seams should be heat sealed or sealed with adhesive conforming to MMM-A-260, as applicable.

d. Waterproof and Water-Vaporproof Wraps. Waterproof and water-vaporproof wraps shall be fabricated and sealed in accordance with MIL-L-10547.

e. Unsealed Waterproof Wraps. Unsealed water-

proof wraps should be applied to shed water while permitting breathing and circulation of air.

1-23. Packing of Metal Containers

Small interior metal containers (vol I, chap 5), used for the shipment of delicate or fragile items, are packed in an exterior container for added protection, ease of identification, and ease of handling.

a. Method of Packing. When making shipments, 12 interior metal containers of the same size are packed in an exterior box. The bottom layer of six containers is inverted and the top layer of six is placed right side up. A plywood spacer is placed between the layers. The spacer has cleats of lumber or plywood nailed to each face, forming pockets to separate the bottoms of the interior metal containers. Some savings in tare and cube of the pack are accomplished by substituting fiberboard partitions and spacers in place of plywood spacer and cleat arrangement. When substitutions are made, the size of the exterior container may be scaled down accordingly.

b. Box Size. The inside length and width of the box is approximately one-eighth inch greater than the length and width of the spacer. The inside height of the box allows approximately one-eighth inch clearance between the tops of the containers and the top of the box. This dimension, therefore, is twice the height of one completely assembled metal container plus one-half inch. (Three-eighths inch spacer plus one-eighth inch clearance equals one-half inch.) When it is necessary to pack interior metal containers in quantities less than 12 per box, the overall dimensions of the box and spacer must be altered accordingly, maintaining clearances within the tolerance specified for the standard 12-container box. The spacer will not be required for a single tier of cans, in which instance the inside bottom of the box should be cleated to perform the function of the spacer.

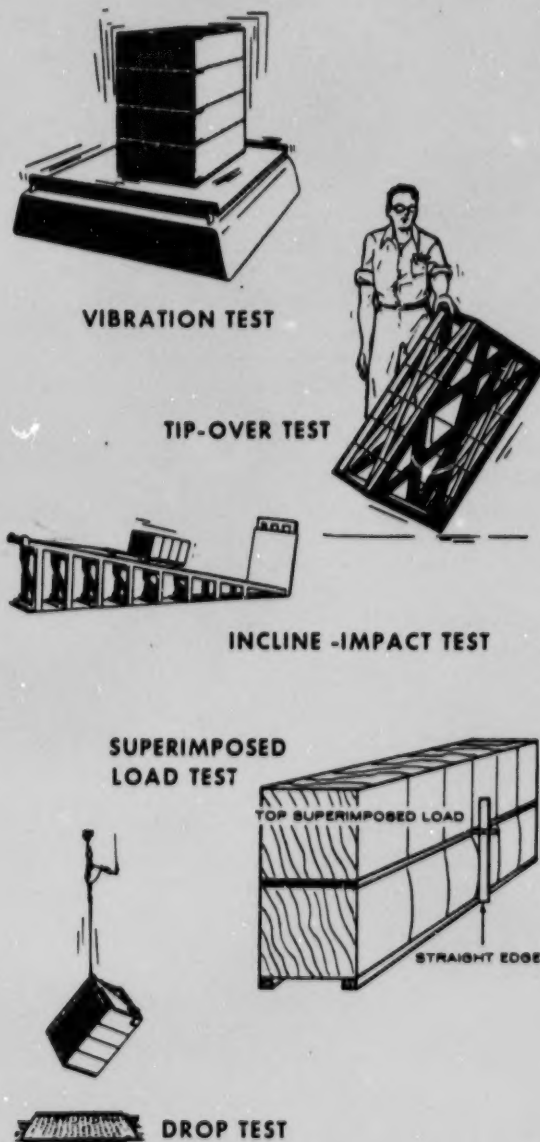
c. Reusable Boxes. Each box constructed in accordance with the foregoing requirements is

intended to be reusable. Therefore, in order to provide efficiency of use, each box should have the words "REUSABLE BOX" stenciled on each end. In addition, the size of the interior metal containers and the capacity of the box should be stenciled on each end of the box as follows: CAPACITY SIZE INTERIOR METAL CONTAINERS. In the first space, show the capacity of the box as to quantity of interior metal containers; in the second space, show the size number of the interior metal containers accommodated. The markings should be arranged to minimize interference with other required markings. Full advantage should be taken of the reusable feature of this exterior container, otherwise much of the value of the reusable interior container is lost. If the box is properly closed by means of four steel straps (two lengthwise and two girthwise), and if its top is fabricated of one piece, no nails are needed to hold the top in place. If no nails are used for closing the container, its life in service will be much longer, as it is seldom possible to withdraw nails without damaging the container.

1-24. Testing of Packs

a. Purpose of Testing. The purpose of testing is to prove the adequacy of packaging design and the workmanship of fabrication. Testing may be performed in the research and development phase or by tests at the operational level. Since containers in the storage and shipment cycle are subjected to various and constantly changing storage and shipping hazards, it is difficult to develop complete data for their design by merely observing the containers in service. Examinations of failures will reveal the weaknesses and suggest the specific principles of design to overcome such failures. Since service tests are not performed under controlled conditions, laboratory tests are necessary to simulate field hazards. Each test is designed to reproduce one or more of the stresses encountered in the field. During the test cycles the sequence of failures can be observed, classified, and the weaknesses from which the failures result determined. By means of such tests any number of containers can, in turn, be subjected to exactly the same actions, thus providing the data necessary to produce balanced construction and workmanship. On the following pages are described a number of methods that have been devised for subjecting containers to hazards similar to those encountered in the field. Both laboratory and field testing are necessary since there are certain conditions inherent in each method of testing that cannot be duplicated in the other.

b. Types of Tests. Development and testing of packages and containers should be started as soon as possible after initiation of item development. Some of the tests most commonly used in proving design adequacy include the vibration, rough handling, and cyclic exposure tests (fig 1-37). One or more of these tests are usually applicable to the design of military packages and packs. In many cases the technical activity having design responsibility, has interval tests and procedures that are applicable to a specific design problem. The documents most generally used for test guidance are



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Figure 1-37. Examples of container tests.

Specification MIL-P-116, Military Standard MIL-STD-1186, and Federal Test Method Standard 101.

c. *Testing (MIL-P-116).* After an item has been packed in accordance with one of the MIL-P-116 methods, tests are conducted to determine the effectiveness of the pack. The types of tests conducted will depend on the particular method used, and are also specified in MIL-P-116. The tests called for in MIL-P-116 are not all-inclusive, however, and additional or different tests are sometimes required. The types of tests specified in MIL-P-116 for proving the adequacy of unit protection are the leakage test, rough handling tests, cyclic exposure tests, and the heat-seal seam tests. See volume I for details.

d. *Testing (MIL-STD-1186).* When packs prepared for shipment in accordance with the detailed requirements of MIL-STD-1186 are tested for any rough handling required, there should be no settlement or shifting of contents. Further, the testing should cause no damage to the contents and should not loosen, break, or displace the anchoring, blocking, or bracing. The testing should not render the interior containers, wraps, liners, barriers, or cushioning ineffectual in providing continued and adequate protection to the contents.

e. *Types of Rough Handling Tests.* The various types of rough handling tests include: free-fall drop test; cornerwise drop test; pendulum-impact test; incline-impact test; edgewise drop test; vibration test; and others. The particular tests employed usually depend upon the size and shape of the package. Completed packages as prepared for shipment are given a rough handling test when specified. When a rough handling test is required, it precedes applicable tests specified to detect leaks and inadequate seals or closures and preservative retention. Inspection and tests for leaks in barrier materials, seals and closures, and preservative retention, when required, are performed on the contained unit pack(s). Following the rough

handling test to determine existence or extent of detrimental effects. Unless a particular test is specified, selection of the applicable rough handling test should be in accordance with (1) or (2), below, as applicable. The drop heights shall be as indicated by MIL-P-116 (see table 1-13) or as specified by Fed Test Method STD 101.

(1) *Small containers.* Only free-fall drop tests and vibration tests shall apply to small containers; both or either vibration test shall be conducted at the option of the contractor. Small containers are those having no one edge or diameter over 60 inches and a gross weight of 200 pounds or less.

(2) *Large containers.* All rough handling tests, except for free-fall tests, shall apply to large containers; both or either vibration test shall be conducted at the option of the contractor. However, tipover tests will apply only when additionally specified. Either impact test shall be conducted at the option of the contractor. Large shipping containers are those measuring more than 60 inches on any one edge or diameter, or those which when loaded, have gross weights in excess of 200 pounds.

(3) *Free-fall drop test (fig 1-38).* The pack may be tested in accordance with test method 5007 of Federal Test Method Standard 101.

(a) A drop tester is any suitable apparatus which will allow an absolutely free, unobstructed fall of the container at the orientation and the direction required. A lifting device that will not damage the container will be used and a level steel or cement surface to absorb all shock without displacement will be provided.

(b) The height from which the specimen should be dropped is dependent upon the weight, size, kind of container, and level of pack.

(c) This test is meant to simulate the fall of an item dropped by a man from a height he would normally use to lift and carry an item of that size.

(d) The container should be dropped from the designated height onto a steel, concrete, or

Table 1-13. Graduated Drop and Impact Test Heights (MIL-P-116)

Gross weight of container and contents	Edgewise-drop test (2 drops each end)	Cornerwise-drop test (2 drops on each of 2 diagonally opposite corners of bottom)	Impact test (1 impact on each of 2 opposite ends) use either test	
	Height of drop (inches)	Height of drop (inches)	Pendulum drop (inches)	Incline impact (feet)
Through 250	30	30	14	7.0
Over 250 through 500	24	24	11	5.5
Over 500 through 1,000	18	18	8	4.0
Over 1,000	12	12	5	2.5

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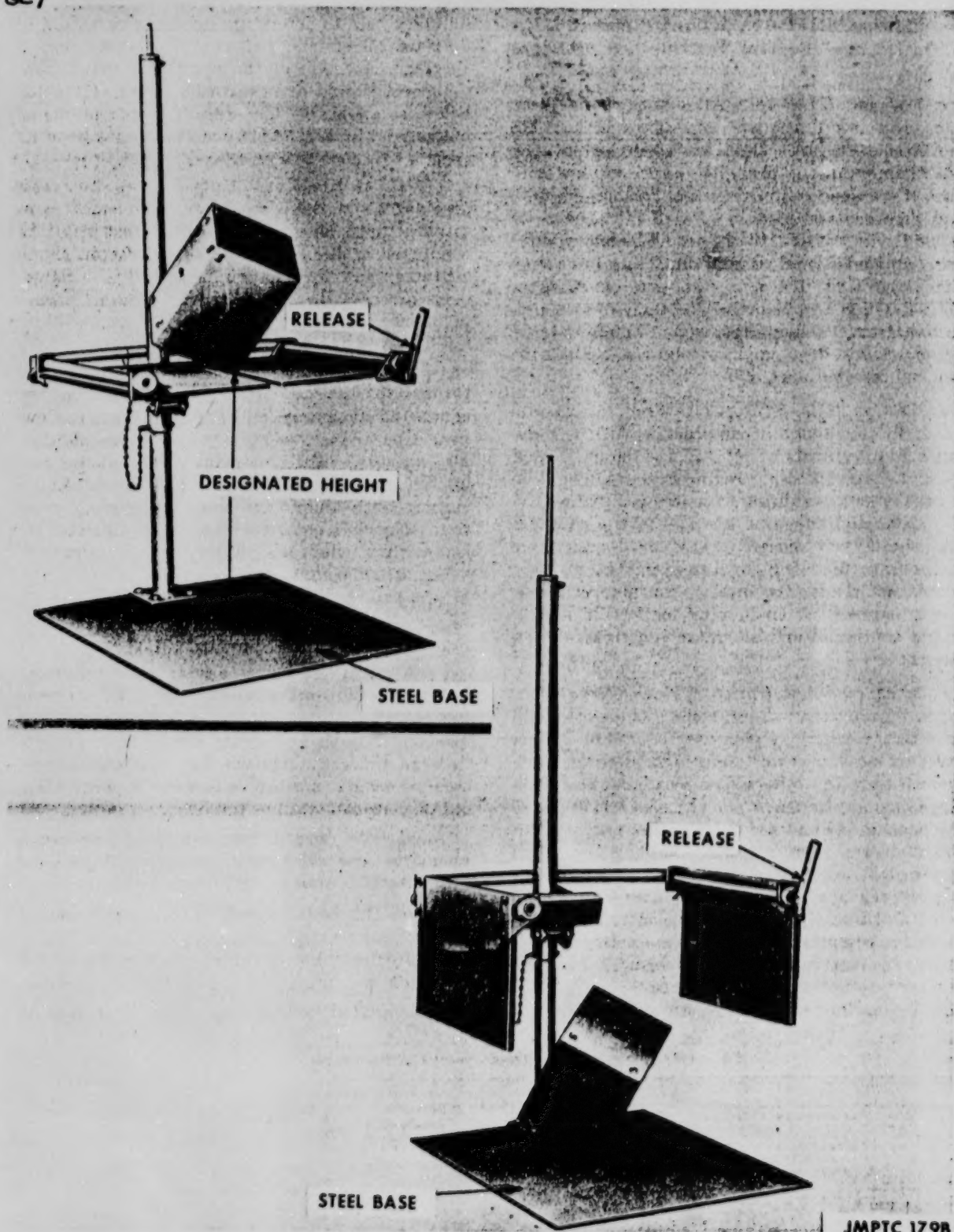


Figure 1-38. Free-fall drop test.

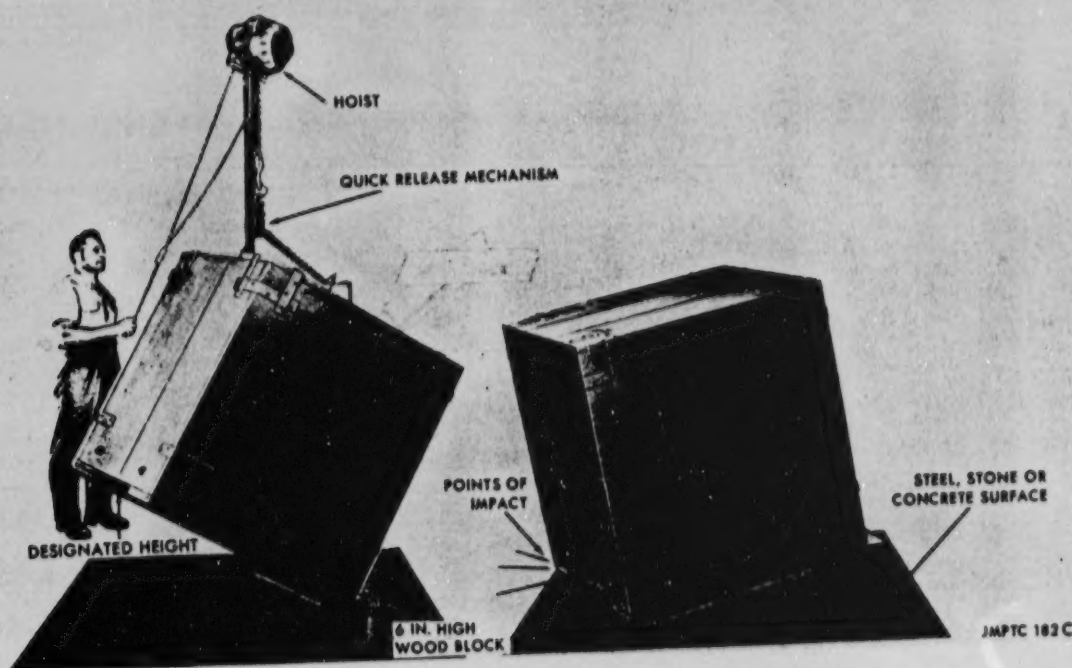


Figure 1-39. Edgewise-drop test.

stone surface of sufficient mass to absorb the shock without deflection in such a manner that the designated surface of the container absorbs the full force of the fall (fig 1-38). This test should be repeated until the designated number of drops have been made. (The height of refers to the distance from the steel, concrete, or stone surface to the nearest surface of the container when suspended prior to the fall.) The fall shall be a free-fall, in that no ropes or other suspending media are attached to the container during the fall. If the container is of the drum type, the top and bottom of the drum should be marked so that the circle of the top and bottom is quartered, and the test should be applied to each quartered section.

(4) *Tipover test (fig 1-37).* The container may be tested in accordance with test method 5018 of Federal Test Method 101. The loaded container is placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side to a smooth, level, concrete slab or similarly unyielding surface. Structural damage to the exterior shipping container which would result in either spilling of contents or failure of the container in subsequent handling is cause for rejection. This test is meant to simulate the impacts of accidentally tipping over a container. It is intended that the tipover test be used only on containers that are susceptible to accidental tipovers.

(5) *Edgewise drop test (fig 1-39).* The pack may be tested in accordance with test method 5008 of Federal Test Method Standard 101. The loaded container should be supported at one end of its base on a sill or block 6 inches in height and at right angles to the skids. The opposite end of the container should be allowed to fall freely from the specified height onto a steel, concrete, or stone surface of sufficient mass to absorb the shock without deflection (fig 1-39). The test should be applied once to each end of the container. If the size of the container and the location of the center of gravity are such that the drop tests cannot be made from the prescribed height, the greatest attainable height should be the height of the drops.

(6) *Cornerwise-drop test (fig 1-40).* The pack may be tested in accordance with test method 5005 of Federal Test Method Standard 101. The container should be supported at one corner of its base on a block 6 inches in height. A 12-inch block should be placed under the other corner of the same end of the container. The lowest point of the opposite end of the container should then be raised to the specified height for the weight and allowed to fall freely onto a steel, stone, or concrete surface of sufficient mass to absorb the shock without deflection.

(7) *Guided-impact test.* Packs having a gross weight exceeding 200 pounds or any dimension

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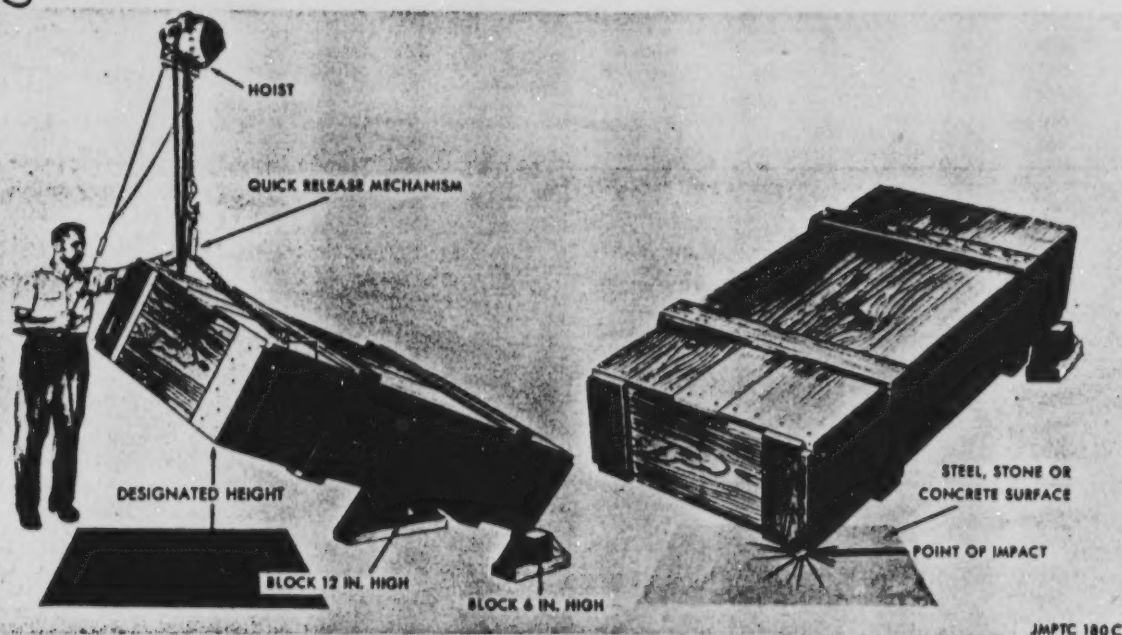


Figure 1-40. Cornerwise-drop test.

exceeding 60 inches, closed for shipment, may be subjected to one of the following guided impact tests. A single impact should be applied to each of two opposite ends. The tests are performed to simulate railroad humping or other accidental impacts, evaluating the adequacy of the blocking, bracing and tie-downs used to secure a load on or in a rail car.

(a) *Pendulum-impact test (fig 1-41).* The pack may be tested in accordance with test method 5012 of Federal Test Method Standard 101. A pendulum-impact tester which consists of a platform suspended from a height at least 16 feet above the floor by four or more ropes, chains, or cables; and a bumper consisting of a flat, rigid concrete, or masonry wall, or other equally unyielding that barrier. The bumper shall be 18 inches high, wide enough to make full contact with the container end, and shall have sufficient mass to resist the impacts without displacement. The impact surface shall be oriented perpendicular to the line of swing of the platform. The platform shall be large enough to support the container or pack, and when hanging free, shall have its top surface approximately 9 inches above the floor, and its leading edge at least 3 inches from surface of the bumper. The suspension chains shall be vertical and parallel so that when the platform is pulled straight back it will raise uniformly but remain at all times horizontal and parallel to the floor. The specimen shall be placed

on the platform with the surface which is to be impacted projecting beyond the front end of the platform so that the specimen just touches the vertical surface of the bumper.

(b) *Incline-impact test (fig 1-37).* The pack may be tested in accordance with test method 5023 of Federal Test Method Standard 101.

1. This test simulates the abuses encountered by packs in freight cars or trucks when the vehicles are subjected to sudden starts and stops.

2. The pack, mounted on a movable platform dolly which rides on a plane inclined 10 degrees from the horizontal, is released from a known distance up the incline and permitted to strike against a fixed backstop at the bottom of the plane. The magnitude of impact shock is varied by using different release points.

(8) *Superimposed-load test (fig 1-37).*

(a) The shipping container may be tested in accordance with test method 5016, stackability, with dunnage, or test method 5017, uniformly distributed without dunnage of Federal Test Method Standard 101.

(b) The procedure (test method 5016) is applicable for determining the ability of shipping containers to resist loads such as imposed on the bottom container of a stack of similar containers in storage, or on a container supporting top dunnage and superimposed lading. Test method 5017 is applicable for determining the ability of ship-

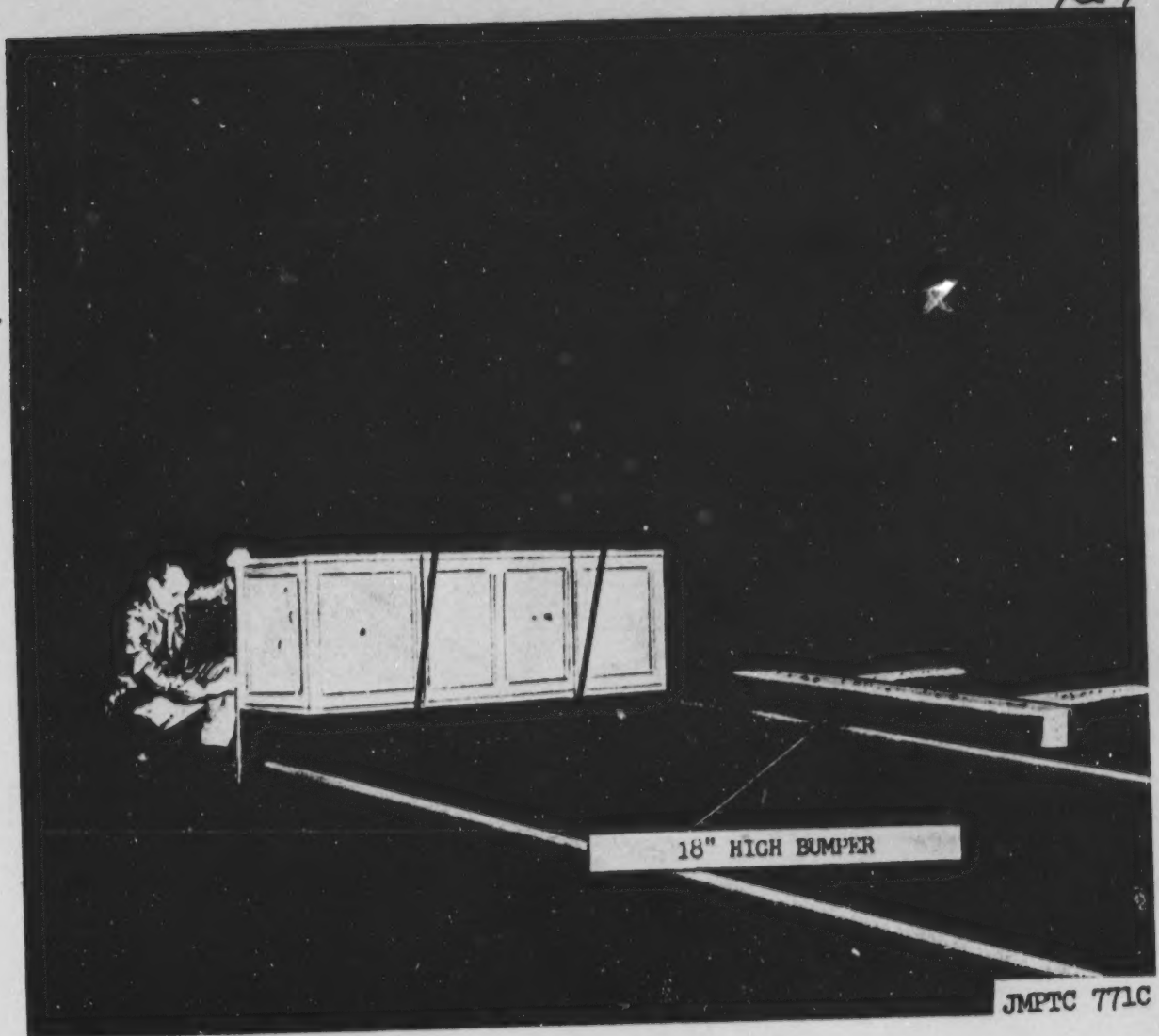


Figure 1-41. Pendulum-impact test.

ping containers to resist loads superimposed on their tops as imposed by piling without top dunnage many small, heavy packs on a container.

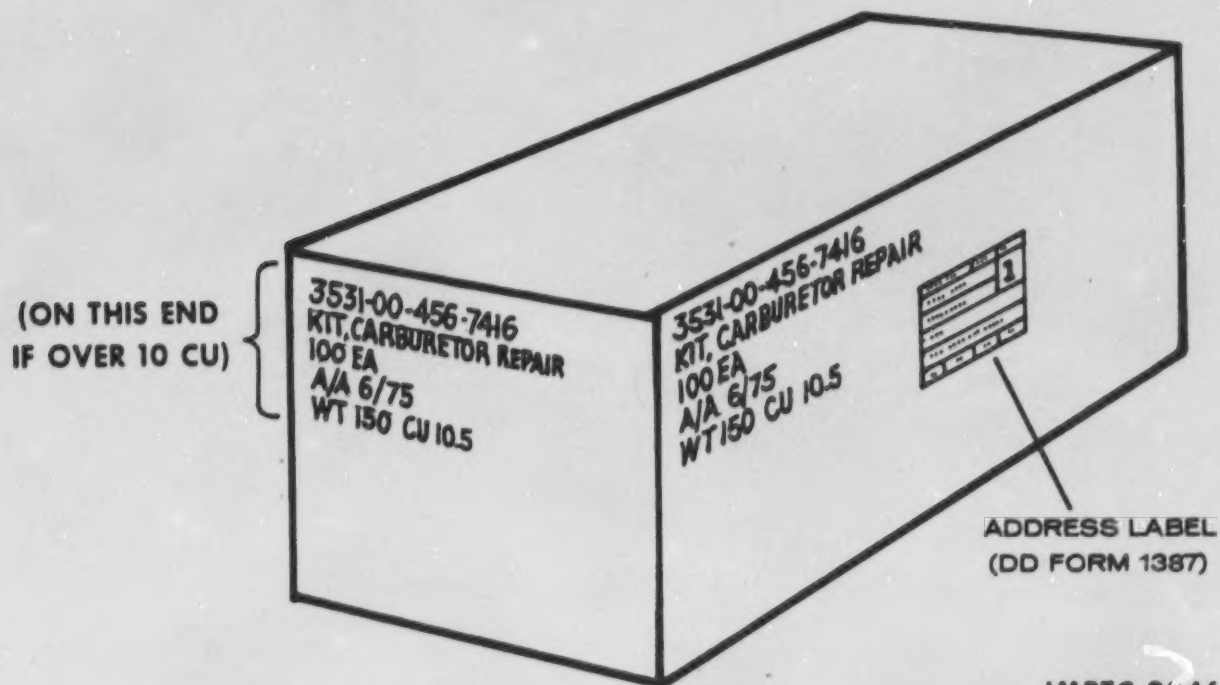
(c) Stackability, with dunnage test are conducted by placing a prescribed load on the top of the container in a manner simulating the effect of similar containers being stacked on top, and the load shall be allowed to remain in place for 1 hour. A check shall be made of any changes or breaks in the container, such as apparent buckling or failure of members in the sides or ends. Observations should be made to determine if the distortions are enough to damage or dislodge the interior packing or contents.

(d) The uniformly distributed, without dunnage superimposed load test is conducted by plac-

ing weights not greater than 10 x 10 inches in outside length and width, on top of the container in a symmetrical pattern approximating uniform load is allowed to remain in place for 1 hour. Measurements of distortions shall be made immediately before the load is removed. Checks should be made of any changes or breaks in the container, such as apparent buckling or failure of members in the top, sides or ends.

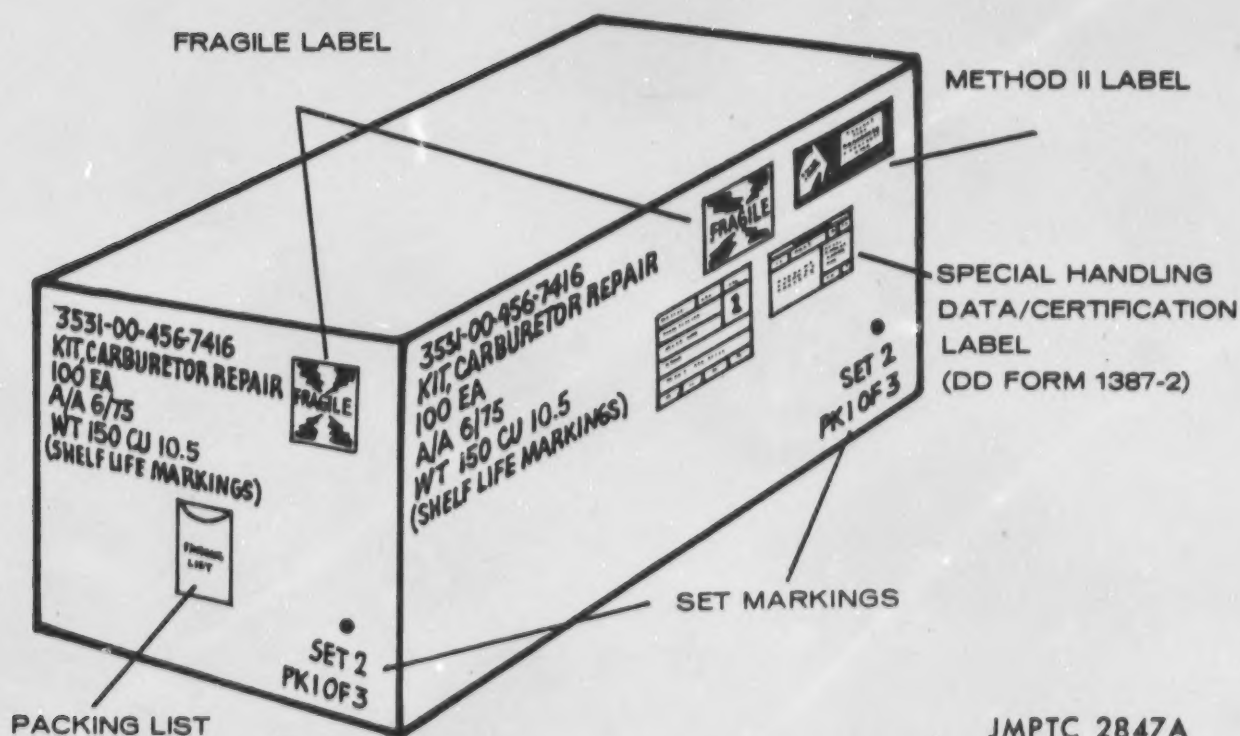
(9) Vibration test (fig 1-37). The pack may be vibration tested in accordance with ASTM Designation D 999, Vibration Test for Shipping Containers, Procedure A or B, or Test Method 5019 or 5020 of Federal Test Method Standard 101, as specified. The duration of the vibration test should be as specified.

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Figure 1-42. Identification and address markings.



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Figure 1-43. Special markings.

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(a) The standard packaging laboratory vibration machine consists of a wooden table supported on two cross shafts, one near each end of the table. Each of the shafts carries two eccentrics which have a total amplitude of 1 inch. The speed or number of cycles per minute and the type of motion may be varied.

(b) Vibration frequently produces deterioration or partial crushing of the unit or interior packing which reduces resistance to other shocks, such as impact from dropping, jolting, or bumping. This test can disclose weakness in assembly of the packed item.

(c) Vibration tests simulate the forces and motions typical of railroad cars, motor trucks, air transportation, etc.

(10) *Simulated contents.* Simulated contents of the same dimensions, weight, center of gravity, and physical properties as the actual contents may be substituted in the tests described above. A shock-recording instrument of an acceptable type should be appropriately installed within the shipping containers. This provision is intended to avoid unnecessary damage or complete destruction of valuable commodities and to avoid hazards to personnel conducting the tests.

(11) *Interpretation of results.* All materials and components comprising the method of preservation shall be free from damage or evidence of displacement which affects the utility of the method of preservation. The material used in the method of preservation should show no visible signs of damage. When specified, functional tests should be conducted on the preserved items or equipment to determine freedom from operational malfunction.

1-25. Marking of Packs

a. Purpose. The purpose of marking is to permit ready identification of contents, consignor and consignee addresses so that shipments can be moved without confusion or delay. No matter how well an item is made or packed, it is valueless if it cannot be identified upon reaching its destination. The Department of Defense procures so many types and makes of equipment, ammunition, materials, and repair parts, particularly during an emergency, that there is insufficient time to trace the origin of a shipment to determine its destination or to open containers to identify their contents.

b. Marking of Packs. The publication for the marking of military supplies is Military Standard 129, "Marking for Shipment and Storage." This

publication has been approved by the Department of Defense for the marking of military supplies and it is mandatory for use by the military services and Department of Defense supply agencies. This standard provides the requirements for the uniform marking of military supplies and equipment for shipment and storage. It accommodates the requirements for coded and in the clear data and the forms required by Military Standard Requisitioning and Issue Procedures (MIL-STRIP) and Military Standard Transportation and Movement Procedures (MILSTAMP) for movement processing.

c. MIL-STD-129. Basic exterior container marking must include the identification and address markings (figure 1-42). When containers of unrelated items are consolidated into a shipping container, the word "MULTIPACK" shall be applied to the shipping container in lieu of the identification marking. The weight and cube will be included on all exterior containers and located just below the identification. Additional special markings may be required depending upon the item and container being shipped (fig 1-43). For further details refer to MIL-STD-129.

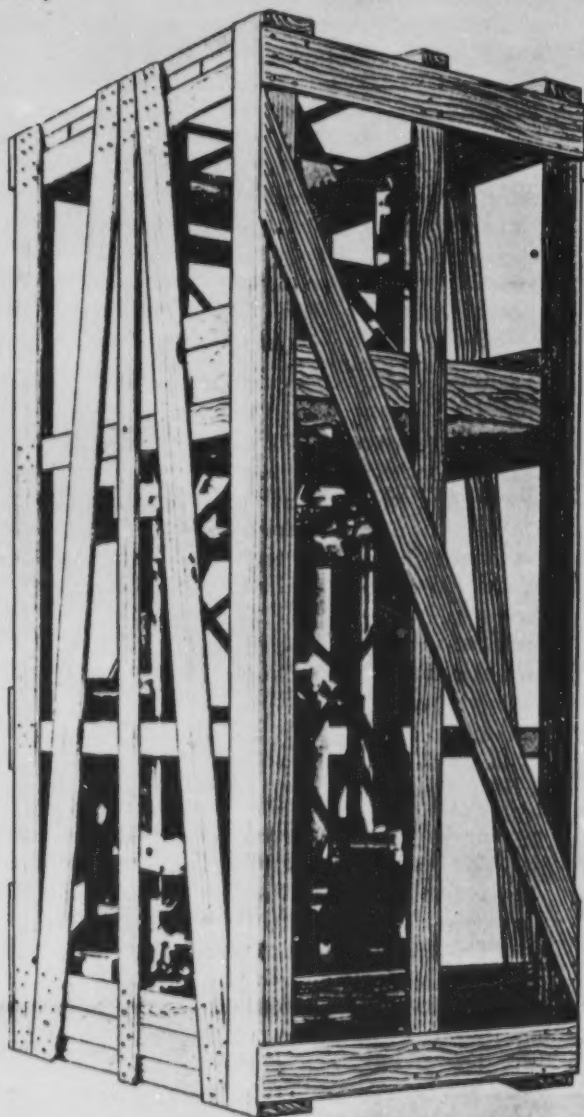
1-26. Economy in Packing

a. Standardization. Economy in packing is the responsibility of everyone concerned with military supply. The Secretary of Defense has established policies on packaging that must be followed. These policies emphasize that the Military Services standardize their preservation, packaging, and packing. For example, the Services, by using packaging standards, assure the same requirements for the same type of items, thus reducing the number of materials, methods, and procedures—whether these requirements are performed by the contractor or by a depot.

b. False Economy. Defense material must be protected against all hazards at the lowest possible cost, with the tare weight and cube kept to a minimum. Any attempt, however, to relax standards to anything less than adequate, is false economy. To associate the size and price of an item with the cost of packing is also false economy. Items of small size or low monetary value are often essential to the proper function of a million dollar assembly. To use more material or more expensive material than is essential is also false economy.

c. Reducing Tare Weight and Cube. One important way to reduce overpacking is through the use of pilot packs carefully engineered and tested for a

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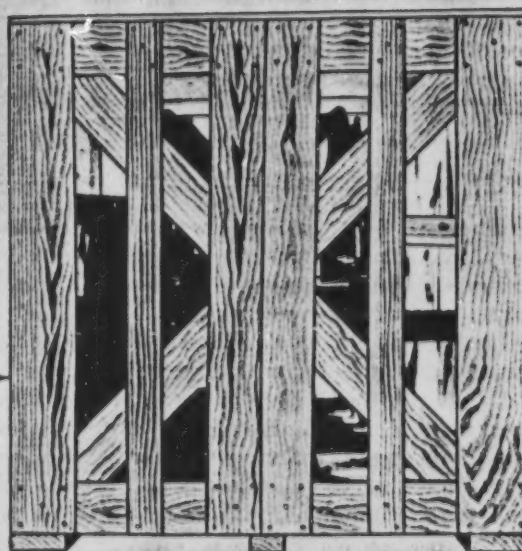


OLD METHOD

WT. 1486 LBS CUBE 222.9

PROBLEMS

SAFETY HAZARD BECAUSE THE
CRATE IS TOP-HEAVY.
WEAK CONSTRUCTION DUE TO
THE EXTREME LENGTH
OF THE SIDE AND END
FRAMING MEMBERS
DIFFICULT TO HANDLE AND LOAD
DUE TO HEIGHT.



NEW METHOD

WT. 1426 LBS CUBE 200.0

SAVINGS IN WEIGHT AND CUBE

WT. 60 LBS CUBE 22.9

PROBLEMS SOLVED BY LAYING
ITEM ON ITS SIDE

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Figure 1-44. Savings achieved through remounting of an item.

particular item. The redesigning of established packs and the use of standardized processing forms may result in substantial savings. Wherever the selection of the container is optional study the comparative initial cost, the labor handling and storage costs, and any possible reduction in tare weight and cube. Probably no area is more fruitful in realizing savings than in the reduction of tare weight and cube.

d. Potential Areas for Economy. There are two areas of great saving potential. One is repair parts and general stores items which account for the greatest shipping volume through high turnover. The other is items of large cubic volume on which shipping charges are high, such as pontoons, fuel tanks, electronic equipment, and machine tools. Figure 1-44 shows an example where savings in weight and cube, together with reduction in top heaviness, were achieved by remounting the item on its side. The length of the crate framing members and diagonals was reduced, and the basic strength of the crate was increased by having the angles of the diagonals nearer to the ideal 45 degree.

e. Economy Procedures. Worthwhile reductions in cost can be realized by following some or all of these procedures:

(1) Disassemble equipment, whenever permissible, into smaller units to minimize storage and shipping space (fig 1-7).

(2) Make vigorous efforts to maintain the moisture content of lumber used for containers, crates, and blocking and bracing within the allowable limits.

(3) Order resawn lumber to reduce weight and cube. By resawing lumber, more board footage per dollar can be obtained. For only 25 percent extra, board footage more than double the amount of surface area can be realized. (Military Handbook MIL-HDBK-7, "Lumber and Allied Products.")

(4) Use the most economical container that will adequately handle the load. For example, do not use a Style 2 wooden box having a load limit of 1000 pounds, when a Style 4 box with a load limit of 400 pounds will give all the protection needed. Do not use a wooden box when a lighter container is adequate for the pack.

(5) Develop an active training program for packing supervisors and personnel to alert them to the constant need for the reduction of weight and cube. Figure 1-45 shows how saving in weight, cube, and materials resulted from a simple redesign of the pack.

(6) Make available a greater selection of light

weight containers on the packing lines. Operators will not be as likely to use heavier containers when fiberboard or other lightweight containers are available and can do just as well.

(7) Consolidate multipack shipments into low cost containers to eliminate the shipping weight of smaller individual containers. The wood, wire-bound, and triple-wall fiberboard pallet boxes are all light in weight, are economical and suitable for consolidating materials for domestic and air shipments.

f. Other Economy Areas. There are several other areas in which economies can be achieved.

(1) *Manpower.* Any reduction in manpower cost will have a definite bearing on the economy of packing. One way to reduce manpower cost is to recognize that the well-trained packer is the economical packer. This means using the right man on the right job.

(2) *Mechanization.* Savings of considerable importance can be derived from the proper use of mechanization. Powerized conveyor belts, mechanized handling systems, and automatic packing machinery, all help to reduce handling and speed up operations.

(3) *Reuse of materials.* Another field in which savings can be effected is through the salvage and reuse of materials. Lumber, cushioning, blocking and bracing materials, containers, and metal fasteners can be reused with a little careful planning (fig 1-44).

(4) *Parcel post.* One other area for achieving savings is the more efficient use of parcel post. Frequently, parcel post reduces the need for documentation, allows a lowering of the level of protection, cuts down on marking requirements, and permits faster delivery. Remember, to obtain the maximum value for each Defense dollar, one must be awake to every new idea that may lead to the reduction in packing costs.

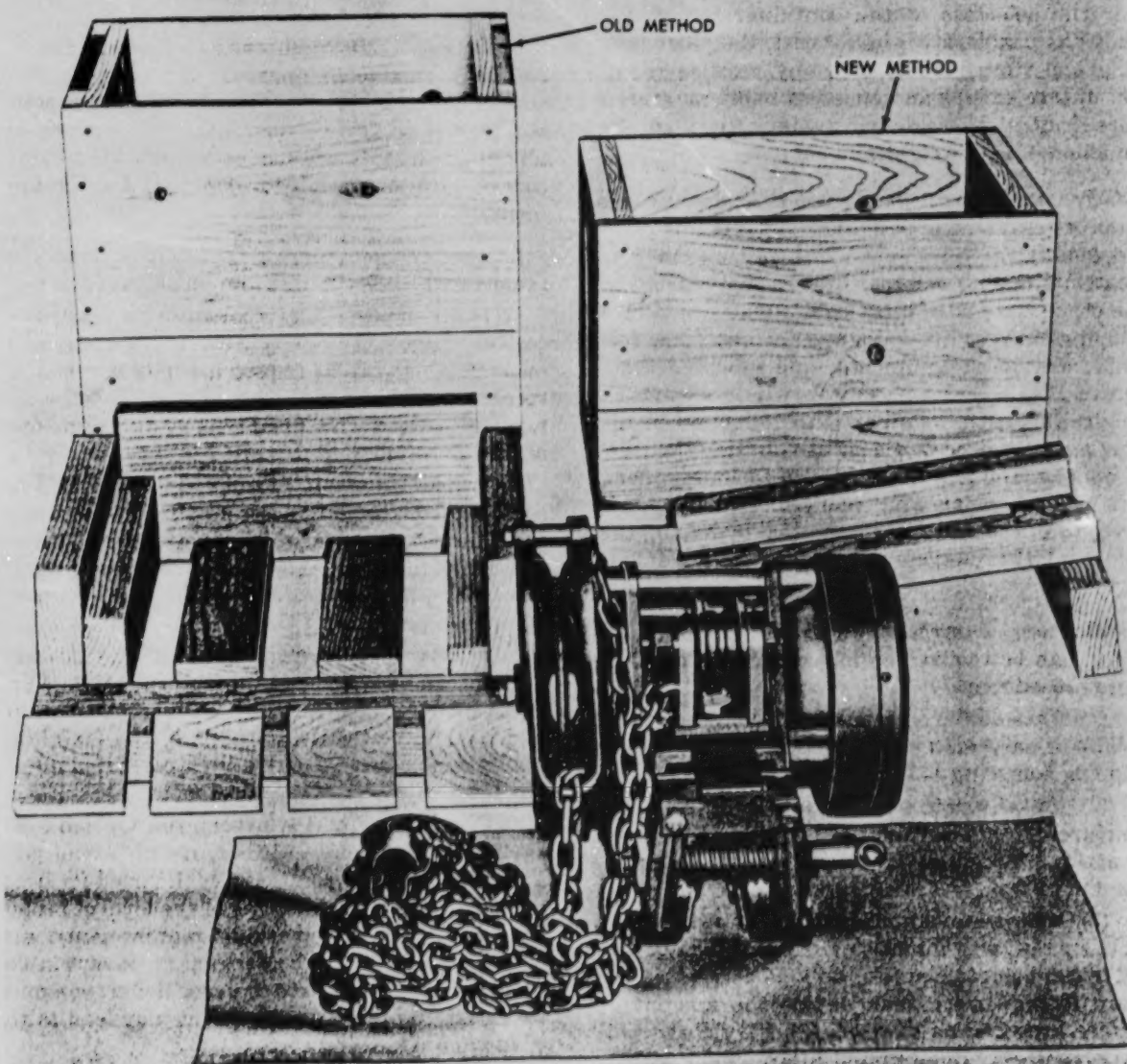
1-27. Parcel Post Requirements

a. General Supplies. Military requirements for parcel post shipments must conform to the Postal Service Manual and the various Armed Service regulations.

b. Nonmailable matter. Nonmailable matter includes all matter which is by law, regulation, or treaty stipulation, prohibited from being sent in the mail or which cannot be forwarded to its destination because of illegible, incorrect, or insufficient address.

(1) *Harmful matter.* Any articles, compositions, or materials, which may kill or injure an-

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OLD METHOD

WT. 151 LBS
CUBE 3.2
METHOD III

NEW METHOD

WT. 132 LBS
CUBE 2.3
METHOD III

SAVINGS

WT. 19 LBS
CUBE .9

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Figure 1-45. Savings achieved by redesigning a pack.

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other or injure the mail or other property, are nonmailable. This includes but is not limited to—

(a) All kinds of poison or matter containing poison.

(b) All poisonous animals, except scorpions, all poisonous insects, all poisonous reptiles, and all kinds of snakes.

(c) All disease germs and scabs.

(d) All explosives, flammable material, infernal machines, and mechanical, chemical, or other device or compositions which may ignite or explode.

(2) *General examples of harmful matter.*

Harmful matter includes, among others, that which is likely to destroy, deface, or otherwise damage the contents of the mailbags or harm the person of anyone engaged in the Postal Service, such as caustic poisons (acids and alkalies), oxidizing materials, or highly flammable solids; or which are likely under conditions incident to transportation to cause fires through friction, through absorption of moisture, through spontaneous chemical changes or as a result of retained heat from manufacturing or processing; explosives or containers previously used for shipping high explosives having a liquid ingredient (such as dynamite), ammunition; fireworks; highly flammable liquids or substances; radioactive materials; matches; or articles emitting a bad odor.

c. *Harmful Matter Requirements.* Harmful items should not be shipped parcel post without prior approval of the Postal Service. Any mailer may, however, request the Postal Service, in advance, for specific rulings as to the mailable of an item. The request should be addressed to the local postmaster, who will forward it to the Bureau of Finance and Administration, US Postal Service, Washington DC 20260, for approval.

d. *Types of Shipping Containers.*

(1) *General.* Postal regulations require containers strong enough to retain and protect their contents from the weight of other mail.

(2) *Common containers used.* The following containers, with applicable specifications, are most commonly used, depending on size, weight, and nature of the article(s): Cotton Mailing Bags (PPP-B-20); Burlap Cotton and Waterproof Laminated Textile Shipping Bags (PPP-B-35); Folding Boxes (PPP-B-566); Fiberboard Boxes (PPP-B-636); Sacks, Shipping, Paper, Cushioned (PPP-S-30); and Cans, Fiber, Spirally-wound (MIL-C-3955).

(3) *Mailbags.* Mailbags may be used as containers for consolidated shipments of unbreakable



Figure 1-46. Reusing packing materials means economy.

13/ or nonfragile items going to the same location, provided projections are cushioned to prevent rupture of the bag during shipment. Use of one of the three available sizes of mailbag should be based on volume of material going to individual customers.

(4) *Used containers.* Used containers in good rigid condition with all flaps intact are acceptable. If a container of desired size cannot be found, a large one may be cut down to meet the needs.

e. Size and Weight of Container. The shipping containers must be of the proper size to accommodate the item(s) being shipped. Sufficient space for cushioning material should be allowed at the time of container selection, avoiding both the underpacking and overpacking of the item and remaining within the weight limitations.

(1) Size and weight of packages mailed at a first class post office (in the United States only) are limited to a weight of 40 pounds. The size is limited to 84 inches, length and girth combined.

(2) Packages mailed at, or to any 2d, 3rd or 4th class post office and to, or from any Army, Air Force, fleet post office, or territory or possession of the United States must not exceed 100 inches in length and girth combined and 70 pounds in weight.

(3) Any air mail parcel, regardless of class of post office involved, can be 70 pounds in weight and 100 inches in length and girth combined.

(4) The weight of an addressed piece of parcel post must be 16 ounces or more.

e. Reusable Containers. The use of reusable containers may be determined by considering the following factors:

(1) When the military characteristics of the item are such that a reusable type container is necessary.

(2) When the container can serve a dual purpose of shipping container and case while the item is in use.

(3) When the item is designated as recoverable-repairable item.

(4) The cost of reusable containers is offset by multiple use as compared to the cost of single shipment, disposable containers.

(5) When the cost of the item and/or its critical characteristics, or the need for periodic inspection

or exercising justifies the use of a reusable container.

f. Outside Wrapping (Closure).

(1) *Small telescoping clipboard boxes.* These boxes may have metal clasps which fold over and hold the two parts together. Further reinforcement is not required.

(2) *Dry nonfragile materials.* These materials may be wrapped in heavy paper and tied with twine. Thin paper bags are not acceptable.

(3) *Self-contained articles.* Articles which are self-contained may be mailed without outside packaging or wrapping. The Post Office Department will not be responsible, however, if the surface or finish of the articles become marred or damaged.

(4) *Fiberboard cartons.* These containers may be wrapped and tied with strong twine or rope. This affords the greatest protection to the contents. A fiberboard carton in good condition need not be wrapped. Parcels may be securely taped if desired.

g. Marking of Parcels and US Mailbags.

(1) Parcels should be marked to show the official mail indicia (penalty wording, etc.), the return address of the shipper, and the in-the-clear address of the requisitioner. Parcels should also be marked to show "shipment serial number" and "date." Exceptions to these marking requirements are covered by directives or by agreements between depots and local post offices.

(2) Marking of US mailbags shipped both domestically and overseas should be tagged in the space located on the locking device to prevent possible opening in transit. Suggested wording of the tag is "OFFICIAL MAIL FOR ORGANIZATION OF ADDRESS. DO NOT OPEN IN TRANSIT."

(3) In addition to the postage tag located on the locking device of the mailing bag, an additional tag will be attached. The tag will notify the local postal authorities that the bag is to be delivered intact to its destination and will contain the complete address to which the bag is destined for, the return address, and the "Postage and Fees Paid, Department of the Army, Air Force, Navy or DLA" indicia (whichever service is involved).

CHAPTER 2

FIBERBOARD AND PAPERBOARD CONTAINERS

2-1. Fiberboard Boxes (PPP-B-636)

a. *Description of Fiberboard Boxes.* A fiberboard box is a container made of one or more pieces of corrugated or solid fiberboard. The pieces are creased, slotted, joined, and folded according to standard styles described in Specification PPP-B-636 and illustrated in figures 2-6, 2-7 and 2-8.

b. *Use of Fiberboard Boxes.* The quantity of fiberboard boxes used in military shipments is increasing steadily and rapidly. A fiberboard box weighs considerably less than a wooden box of the same capacity. This difference in weight is a factor when large shipments are involved, as any saving of weight is reflected in lower shipping cost and easier handling. The main requirements for a shipping container are light weight, low cost, ability to withstand rough handling, and ability to protect the contents against loss or damage. New facilities, such as motor trucks, airplanes, container cards, skid platforms, lift trucks, platform slings, and palletized loads have been important factors in reducing transportation and handling hazards, thus expanding the use of lightweight fiberboard boxes.

c. *Advantages in the Use of Fiberboard Boxes.* Fiberboard boxes are adaptable to a great variety of packaging and packing conditions. They offer the following advantages:

- (1) They are made of materials of exactly the specified strength and water resistance.
- (2) They are prefabricated.
- (3) They are made in several styles to suit different shapes and sizes of items.
- (4) They are shipped and stored in the flat, and hence save shipping and storage space.
- (5) They are easy to assemble and handle.
- (6) They are light in weight and relatively strong.
- (7) They are neat in appearance and easy to mark.
- (8) When packed, they occupy less space than most other containers of the same inside dimensions.

d. *Classification of Fiberboard Boxes.* Fiberboard boxes, for domestic and oversea shipments, have been consolidated under Specification PPP-B-636. Fiberboard material must conform to Specification PPP-F-320. Boxes may be procured or fabricated in the following types and classes:

(1) *Types (fig 2-1).*

(a) *Type CF boxes.* Type CF boxes are fabricated from corrugated fiberboard (CF) stock (*h* below). Corrugated fiberboard is of two varieties.

1. SW variety is single-wall construction.
2. DW variety is double-wall construction.

(b) *Type SF boxes.* Type SF boxes are fabricated from solid fiberboard (SF) stock (*h* below).

(2) *Classes.*

(a) *Class domestic.* Domestic class boxes are made to meet either normal or special requirements. Under normal requirements, the boxes are used as single-trip containers and no multiple shipments are involved. Under special requirements, the boxes are used where more hazardous storage and shipping conditions are expected (fig 2-1).

(b) *Class weather-resistant.* Weather-resistant boxes are made to meet either normal or special requirements (fig 2-1).

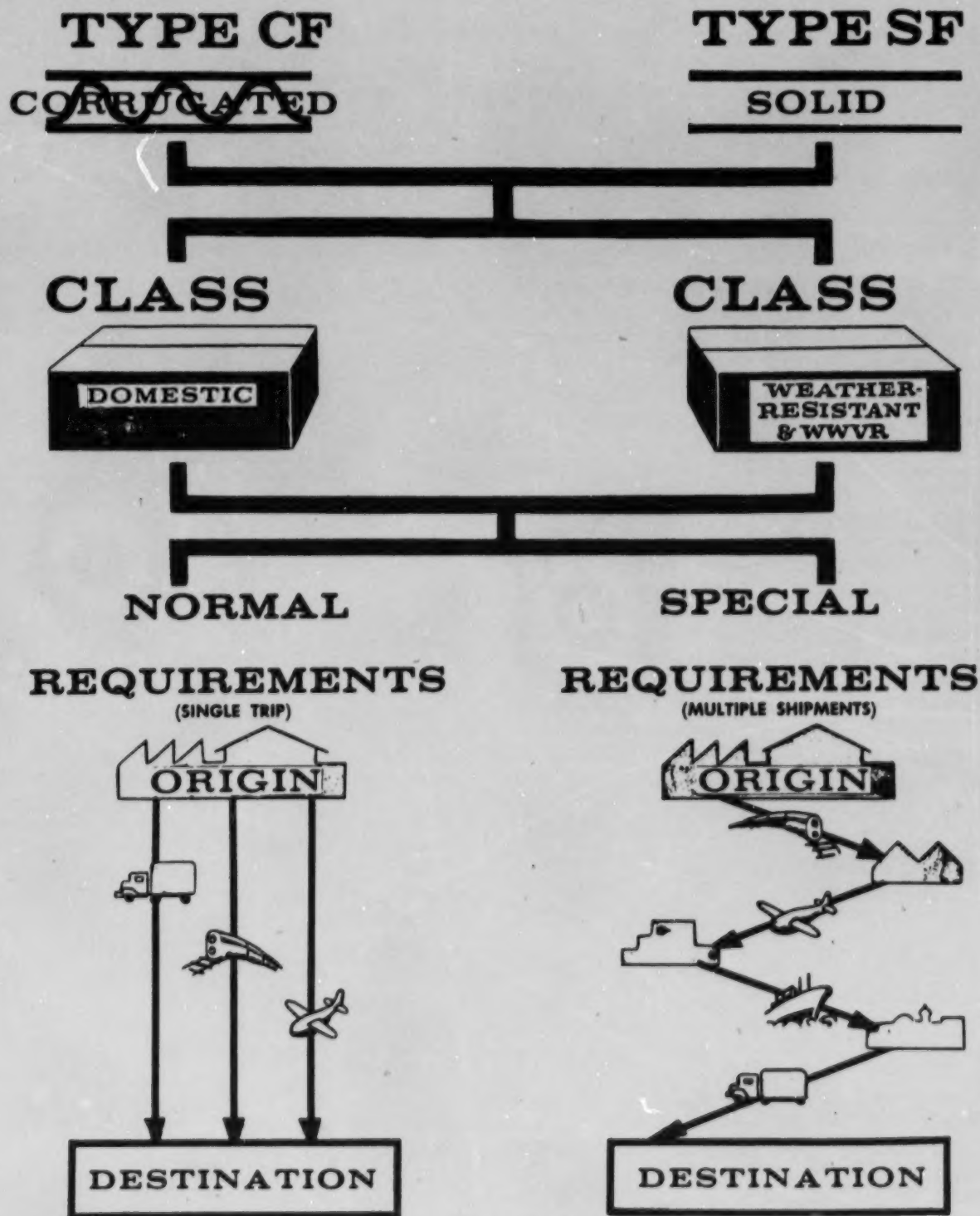
(c) *Class waterproof and water vapor resistant (WWVR).* WWVR boxes are made to meet either normal or special requirements the same as class weather-resistant boxes (fig 2-1).

(3) *Grades of fiberboard.* Different strengths of fiberboard are indicated as grades.

(a) Domestic grades of fiberboard, types CF and SF, are differentiated by psi (pounds per square inch) of bursting strength (table 2-1).

(b) Weather-resistant grades of fiberboard are differentiated by a letter-number combination such as V2, V3, W5 and W6 which represent different bursting strengths. The numeral in each combination represents the grade of material and the letter in each combination represents a kind of fiberboard (V- or W-board). V-board is a heavy-duty, highly weather-resistant board, and W-

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Figure 2-1. Classification of fiberboard boxes.

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Table 2-1. Requirements for Class Domestic Fiberboard Boxes

Type CF		Type SF	Normal requirements		Special requirements	
Variety			Max. wt. of box and contents (lbs)	Max. inside dimensions L + W + D (inches)	Max. wt. of box and contents (lbs)	Max. inside dimensions L + W + D (inches)
SW Grade	DW Grade					
125		125	20	40		
175		175	40	60	20	60
200	200	200	65	75	45	75
275	275	275	90	90	65	90
350	350	350	120	100	90	100
	500	500	140	110	120	110
	600	600	160	120	140	120

board is a lower strength, highly weather-resistant board.

1. Type CF (corrugated fiberboard) can be obtained in grades 3, 5, 6, 11, 13, and 15 with compliance symbols of V3c, W5c, W6c, V11c, V13c and V15c. The small c indicates corrugated fiberboard.

2. Type SF (solid fiberboard) can be obtained in grades 2, 3, 4, 5, and 6 with compliance symbols of V2s, V3s, V4s, W5s, and W6s. The small s indicates solid fiberboard.

(c) Waterproof and water vapor resistant (WWVR) grades of fiberboard are differentiated by a letter-number combination followed by the letters "WWVR." Waterproof and water vapor resistant boxes are fabricated from type CF (corrugated fiberboard) and can be obtained in grades V3c, WWVR and W5c, WWVR in the single wall variety and grades V11, WWVR and V13, WWVR in the double-wall variety.

e. Capabilities of Fiberboard Boxes. The three principal factors affecting the carrying capacity of corrugated and solid fiberboard boxes are resistance to compression, strength at the score lines, and resistance to puncture. A fourth factor that should be taken into consideration is the ability of fiberboard to resist the weakening effect of moisture. The importance of the first three factors varies according to the commodity for which a particular box is designed, and the type of interior packing employed. Resistance to compression, for example, is a relatively minor factor when the contents support the walls of the container or when the interior packing furnishes the necessary support. When these factors are not present, the shipper must make certain that the container has sufficient resistance to compression to prevent it from caving in when it is placed in the bottom tier of a pile of similar boxes. Corrugated and solid fiberboard boxes may be used to ship articles that are not readily susceptible to damage resulting

from ordinary distortion of the container. The manner in which a commodity is packed governs to a great extent its condition on arrival at destination. Therefore, the selection of the proper style, class, and grade of fiberboard box should be carefully considered to ensure the commodity against the hazards of storage, shipment, and handling. The items normally packed in fiberboard boxes are type 1 or type 2 loads (para 10). Type 3 loads should be converted to type 1 or 2 loads by proper interior packing.

f. Uses and Limitations of Class Domestic Fiberboard Boxes. The uses of fiberboard boxes are essentially as indicated in d(2) above. Many variations of special die-cut inserts, scored pads, and partitions (fig 1-31 and 1-32) can be fabricated to give additional protection to the item. Table I of Specification PPP-B-636, reproduced here as table 2-1, is used to determine the applicable requirements when class domestic fiberboard boxes are needed. The normal requirements column is used for single trip-containers; the special requirements column applies to multiple or hazardous shipments (fig 2-1). The columns for corrugated and solid fiberboard (CF and SF) show the minimum bursting strength of the fiberboard in pounds per square inch which determines the grades.

g. Uses and Limitations of Class Weather-Resistant and WWVR Fiberboard Boxes. V-board was developed primarily for the fabrication of exterior containers for overseas shipment. W-board was developed primarily for the fabrication of interior containers which are packed in exterior containers for overseas shipment. At overseas points, the exterior pack is sometimes removed and the W-board boxes become the exterior containers. When W-board boxes are used as exterior containers, their weight and dimensional limitations should not be exceeded. Although both V- and W-boards are highly water resistant, boxes made

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Table 2-2. Size and Weight Limitations for Class Weather-Resistant and WWVR Fiberboard Boxes Used as Exterior Containers

Grade (compliance symbol)	Normal requirements		Special requirements		
	Maximum weight of box and contents	Maximum inside dimensions of box (length, width, depth added)	Maximum weight of box and contents		Maximum inside dimensions of box (length, width, depth added)
	Type 1 and 2 loads Pounds	Type 1 and 2 loads Inches	Type 1 load Pounds	Type 2 load Pounds	Type 1 and 2 loads Inches
V2s	120	100	80	65	80
V3s, V4s and V3c	90	90	75	45	75
W5s and W5c	65	75	55	40	55
W6s and W6c	30	30	25	25	30
V11c	160 ¹	120	160	160	120
V13c	120	100	120	120	100
V15c	90	90	90	90	90

¹ Maximum weight may be increased to 225 pounds provided the manufacturer's body joint is fastened with flat metal staples not less than 0.108 inch wide by 0.028 inch thick when made of flat wire, or not less than 0.103 inch wide by 0.020 inch thick when made of accurate wire, spaced not more than 1 inch apart.

from these materials will permit the entrance of water through the corners and joints. When packed items are of such a nature as to be damaged by water, waterproofing is provided by the use of individual wraps of material conforming to Specification PPP-B-1055 or MIL-B-13239 (fig 1-34); by the use of case liners conforming to Specification MIL-L-10547 (fig 1-35 and 1-36); or by the use of waterproof, pressure-sensitive tape conforming to Specification PPP-T-60, or PPP-T-76, applied as shown in figure 2-2 after proper closure of the box in accordance with n(2) and (3) below. Table II of Specification PPP-B-636, herein reproduced as table 2-2 is used to determine the weight and size limitation when class weather-resistant fiberboard boxes are required. Compliance symbols are given in the first column, V2, etc. The remainder of the table is divided into "Normal requirements" and "Special requirements". The normal requirements column is used for single-trip containers, the special requirements column applies to multiple shipments (fig 2-1). Maximum weight of box and contents are listed for type 1 and type 2 loads under both normal and special requirements. Maximum total inside dimensions are also given for type 1 and 2 loads under both normal and special requirements.

h. Materials.

(1) *Corrugated fiberboard, type of.* Corrugated fiberboard is fabricated of flat sheets of paperboard (called facings) glued to the crowns of a corrugated sheet of the same material. Strength requirements are obtained by varying caliper, number, and quality of the component facings and the corrugated medium. Corrugated fiberboard has low resistance to puncture but affords a high degree of resilience and cushioning. Single-wall,

SW (also called double-faced), corrugated fiberboard consists of two outer paperboard facings laminated to a corrugated sheet between them (fig 2-3). Double-wall, DW, corrugated fiberboard consists of three flat facings and two corrugated sheets in the following sequence a facing, a corrugated sheet, a center facing, a corrugated sheet, and a facing (fig 2-3). It is this combination of flat and corrugated sheets that gives corrugated fiberboard its qualities of strength and resilience. Corrugated fiberboard is constructed with different kinds and arrangements of flutes. A flute, with 36 plus or minus 3 flutes per linear foot, is generally used where cushioning of contents is desired. B flute, with 50 plus or minus 3 flutes per linear foot, is used where the contents that support the box are of low fragility. C flute, with 42 plus or minus 3 flutes per linear foot, can be made to serve either purpose (fig 2-4). A flute is the largest of the three and its strength is realized in stacking applications. Its ability to withstand impact as well as its resistance to flat crushing is the lowest of the three flute sizes due to the lesser number of flutes per linear span. The smallest standard flute size, B, is the weakest in terms of stacking strength, but it performs very well under puncture and flat crush stress. C which is the middle size flute will perform moderately well in all three areas, stacking, puncture, and flat crush. It is used where maximum strength in any one area is not required, but where weakness in no area can be tolerated.

(a) *Domestic fiberboard boxes.* Variety SW fiberboard used to fabricate type CF boxes will be A, B, or C flute at the option of the supplier. Variety DW fiberboard used to fabricate type CF boxes will be any combination of A, B, or C flutes, except BB. Type CF boxes, fabricated from vari-

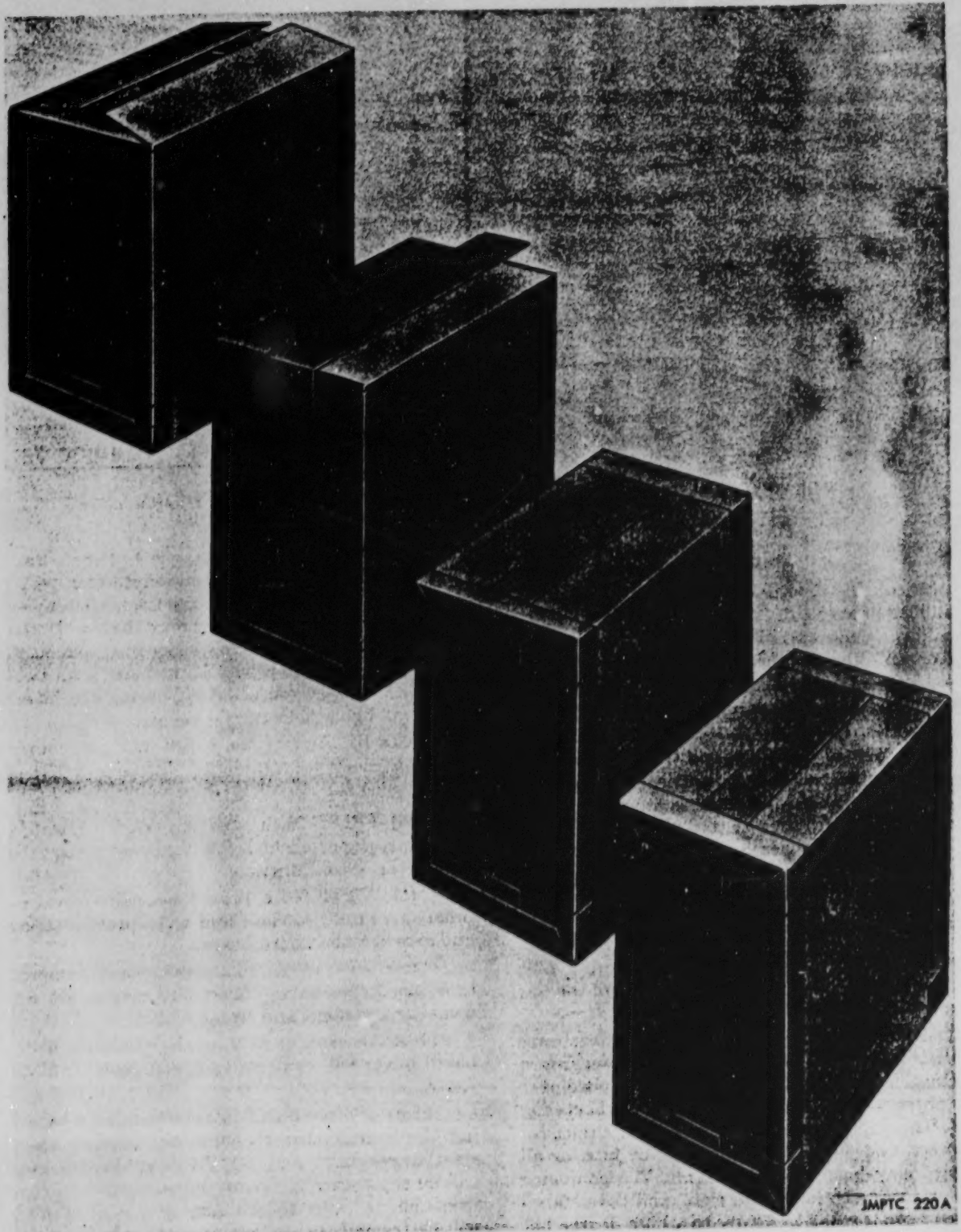


Figure 2-8. Waterproofing of fiberboard boxes with tape.

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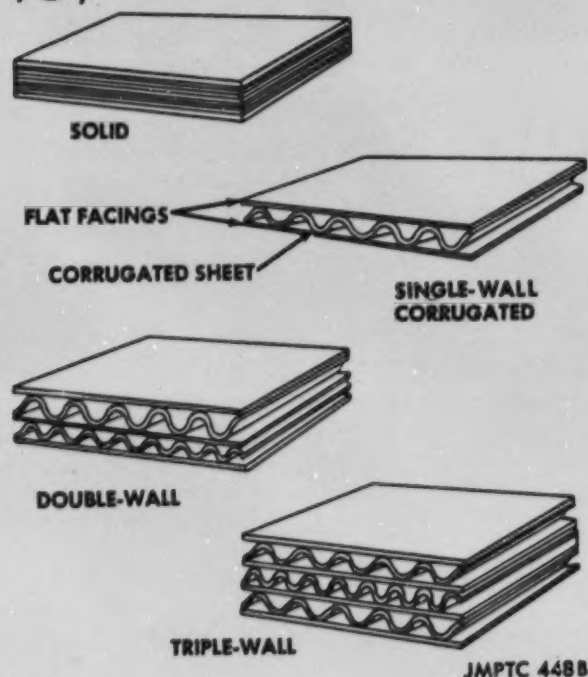


Figure 2-3. Types and varieties of fiberboard.

ety SW or DW fiberboard shall have the flutes running perpendicular to the scores of the box openings. When specified, the flutes for variety SW or DW fiberboard will run horizontal to the scores of the box openings for boxes of a size that the top and bottom openings are on the smallest panels.

(b) *Weather-resistant and WWVR fiberboard boxes.* SW fiberboard used to fabricate type CF boxes will be B or C flute unless otherwise specified, conventional slotted type CF boxes shall have the flutes run perpendicular to the scores of the box openings. When specified, the flutes for these boxes shall run horizontal to the scores of the box openings for boxes of a size and style that the top and bottom openings are on the smallest panel. For Styles DBLCC and IC boxes (fig 2-8), they shall have the flutes run the depth of the box perpendicular to the opening.

(2) *Solid fiberboard, Type SF.* Solid fiberboard consists of several sheets or plies of paperboard laminated together with an adhesive applied over the entire area of contact between the sheets (fig 2-3). The paperboard may be sheets of chipboard between two outer sheets of kraft or jute, or all sheets may be of jute and kraft. The combined material is solid, hard, and rigid, and boxes fabricated from it resist puncture to a high degree but offer little cushioning to their contents. They do,

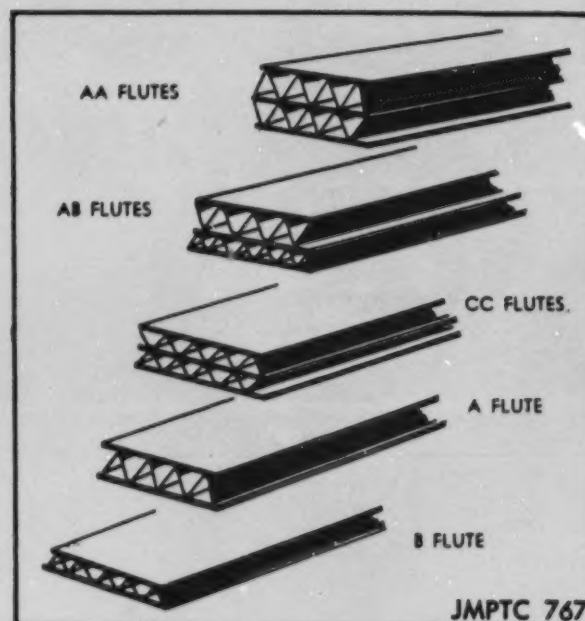


Figure 2-4. Corrugated fiberboard flutes.

however, offer greater resistance to rough handling and wear, and are better adapted for use in shipping heavier and less fragile items than those shipped in corrugated fiberboard boxes. If the weight of the box and contents does not exceed 40 pounds, the fiberboard will be not less than two-ply. If the weight exceeds 40 pounds, the fiberboard will be not less than three ply.

(3) *Tapes.* Among the tapes most commonly used for closing and sealing fiberboard boxes are—

(a) PPP-T-76, a pressure-sensitive water-resistant, paper-backed tape, normally used to close interior containers.

(b) PPP-T-60, a pressure-sensitive water-proof tape, used to close and waterproof interior and exterior fiberboard boxes.

(c) PPP-T-45, a reinforced, paper-gummed tape, used for sealing fiberboard containers for domestic shipment and storage.

(4) *Adhesive.* Adhesive used for closing fiberboard boxes will conform to Specification MMM-A-250.

(5) *Metal fastenings.* Metal fastening for securing the manufacturer's joint and closing class weather-resistant and WWVR fiberboard boxes, will be commercially preformed staples or staples from commercial steel stitching wire. The staples will be treated with a commercially applied coating of zinc or copper wash to resist corrosion.

Staples may be flat or arcuate (arced) and may be of various sizes. Military Specification PPP-B-636 specifies the sizes of staples to use.

(6) *Reinforcing materials.* Steel strapping, Specification QQ-S-781; nonmetallic strapping, Specification PPP-S-760; or pressure-sensitive, filament-reinforced taped, Specification PPP-T-97 are used to reinforce packed and closed fiberboard boxes.

i. Fabrication of the Boxes.

(1) *Cutting, scoring, and slotting.* Special machines are used to cut, score, and slot the fiberboard material so that it can be made into a box.

(2) *Body joint (manufacturer's joint).*

(a) *Domestic boxes, types CF and SF.* The body joint (manufacturer's joint) of domestic corrugated fiberboard boxes will be either lapped, butted, or spliced, as specified (fig 2-5). On domestic solid fiberboard boxes only lap joints are permitted.

1. *Lapped joint.* The lap may be either on the inside or outside of the box and not less than 1 1/4 inches overlap. On a type CF box it may be secured by staples, stitching wire, or adhesive, and on a type SF box it may be secured by staples or stitching wire only.

2. *Butted joint (type CF only).* The butted joint will be secured with gummed tape not less than 2 inches wide for gross weights up to 65 pounds, inclusive, and not less than 3 inches wide for gross weights in excess of 65 pounds. The tape shall be centered on the joint, extend its full length or within 3/8 inch of full length and adhere over at least 90 percent of the entire area of contact with the fiberboard.

3. *Spliced joint.* This joint is permitted only on double-wall corrugated fiberboard. The spliced joint is effected by removing the corrugated media and center liner and splicing inner and outer facings over the end of the abutting corrugated fiberboard. The overlap will extend not less than 1 inch. Both facings must be securely glued over the entire area of contact between the facings.

(b) *Weather-resistant and WWVR boxes, type CF and SF.* Only the lap joint may be used on weather-resistant and WWVR grade boxes (fig 2-5).

1. The lap joint will overlap either inside or outside the box not less than 1 1/2 inches, and will be secured with steel staple or steel stitching wire. The staples or stitches will be spaces not more than 2 inches apart, and the distance between the outer stitches and the end of the joint

will not exceed 1 inch. An additional tie-stitch will be used about 1/2 inch from the outer stitches at each end of the joint.

2. In lieu of a tie-stitch joint, boxes may be stapled or stitched with the same number of fasteners (including tie-stitches) equally spaced in a single row.

3. When specified, the body joints of grades W5c, W6c and V3c fiberboard boxes may be secured by the use of adhesive conforming to Specifications MMM-A-250.

j. Styles of Fiberboard Boxes. The styles covered in figures 2-6, 2-7, and 2-8 are the basic styles of domestic, weather-resistant and WWVR fiberboard boxes.

(1) *RSC, regular slotted box.* In this design, all the flaps (inner and outer) are of equal length. The outer flaps meet in the center when closed. This style is the most commonly used.

(2) *CSSC, center special overlap slotted box.* This box is designed so that the inner and outer flaps meet in the center giving a double thickness for top and bottom.

(3) *CSOSC, center special overlap slotted box.* This box is designed the same as the CSSC except the outer flaps are the same length as the inner flaps and may overlap. No flap cutting is required.

(4) *FTC, full telescope design box.* This design consists of top and bottom trays. The depth of the cover is made equal to the overall depth of the bottom tray. This style of box, when closed, has a triple thickness of fiberboard on all four corners, affording good slacking strength.

(5) *SFF, special full flap slotted box.* In this design, the outer flaps fully meet on the center, resulting in a triple thickness of fiberboard on the top and bottom. The length of the outer flaps will be not less than the inside width of the box minus 1 inch.

(6) *FOL, full overlap slotted box.* In this design, the outer flaps fully overlap and the inner flaps are of the same length as the outer flaps. If the shape of the container is such that it would result in an overlap of the inner flaps, they will be cut to meet in the center. This design results in a container with at least two thicknesses of fiberboard covering the entire top and bottom surfaces.

(7) *OSC, overlap slotted box.* In this box, when closed, the inner flaps must not overlap, and the outer flaps will overlap the distance specified in the order or invitation for bids. The inner flaps will be of the same length as the outer flaps, except when the relation of width to length would

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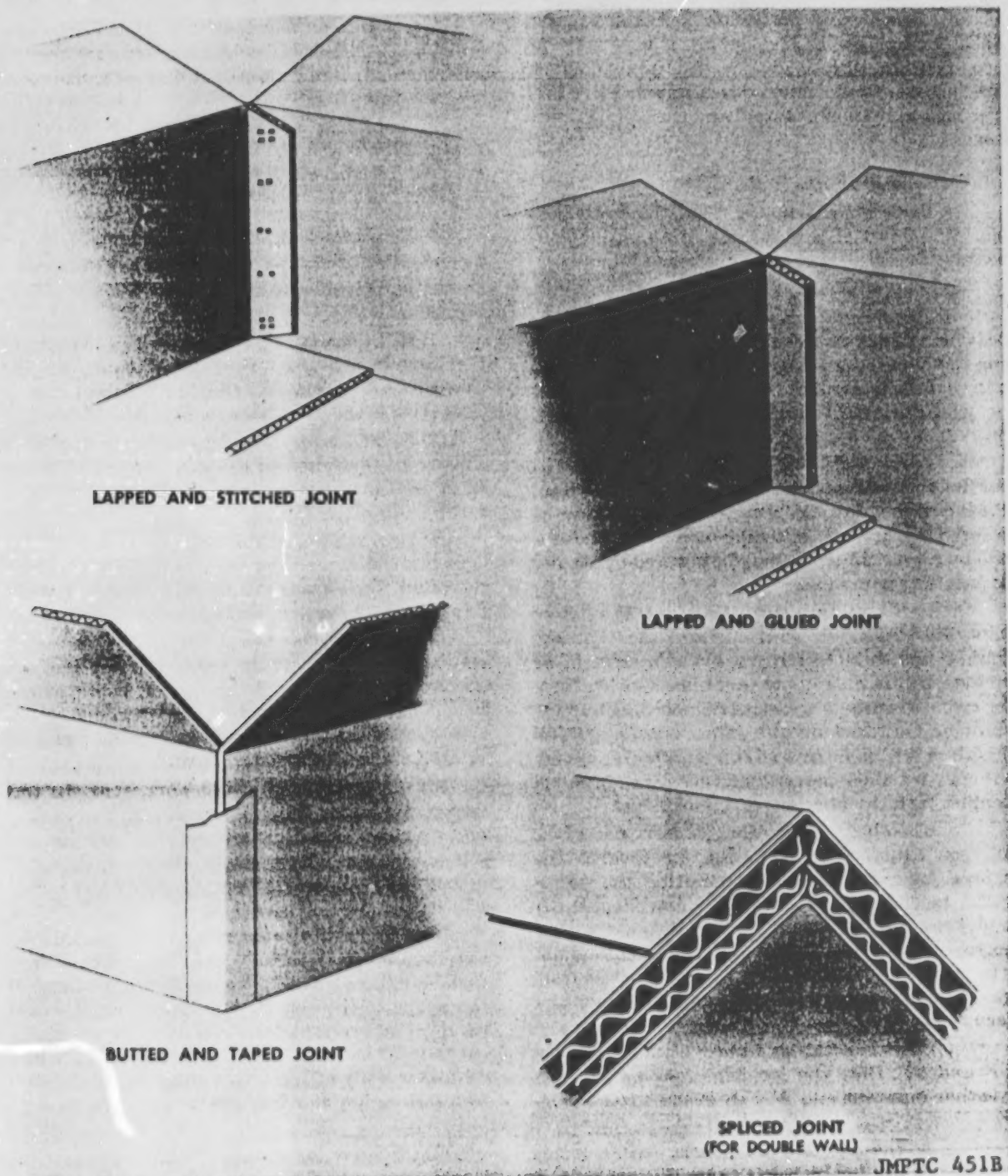
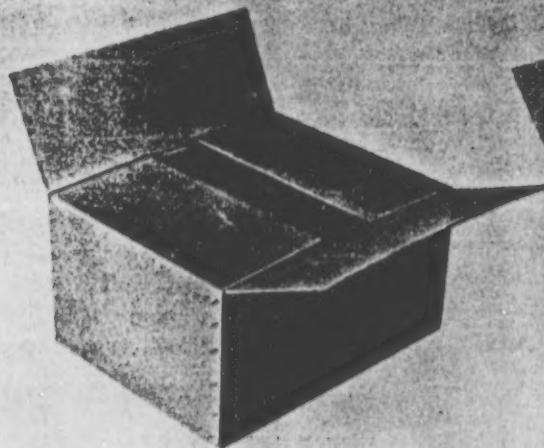


Figure 2-5. Body joints for fiberboard boxes.

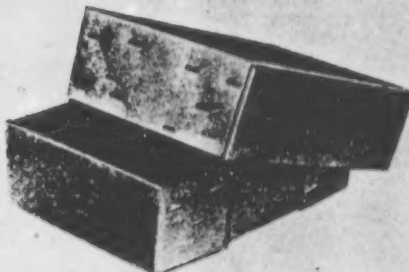
140



REGULAR SLOTTED BOX STYLE-RSC



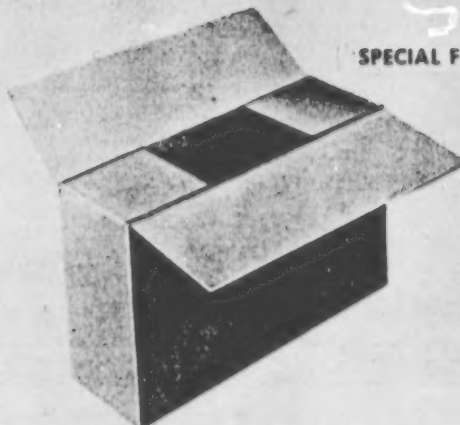
CENTER SPECIAL SLOTTED
BOX STYLE-CSSC
OR
CENTER SPECIAL OVERLAP
SLOTTED BOX STYLE-CSOSC



FULL TELESCOPE BOX STYLE-FTC



SPECIAL FULL FLAP SLOTTED BOX STYLE-SFF

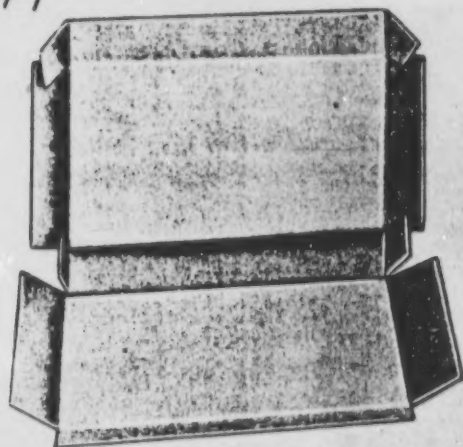


FULL OVERLAP SLOTTED BOX STYLE-FOL

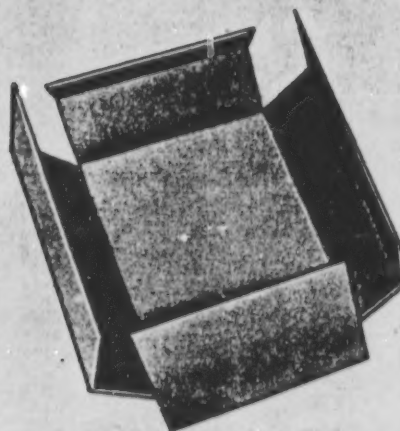
JMPTC 2665

Figure 2-6. Styles of fiberboard boxes.

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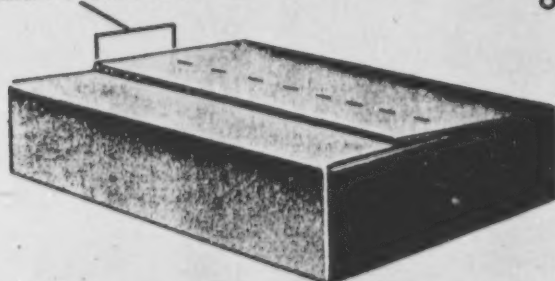


FIVE-PANEL FOLDER-FPF

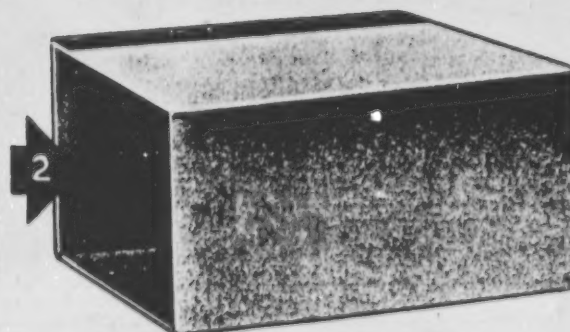
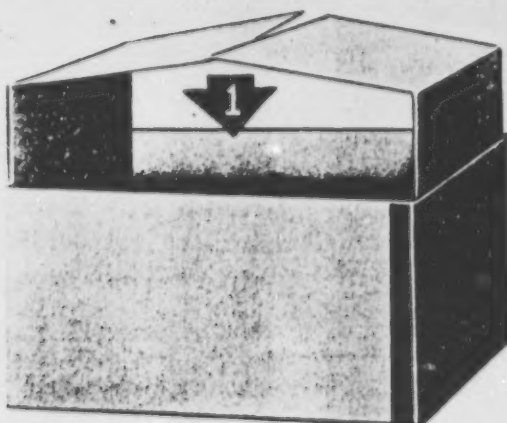


ONE-PIECE FOLDER-OPF

MINIMUM OVERLAP-2 IN



OVERLAP SLOTTED CONTAINER-OSC

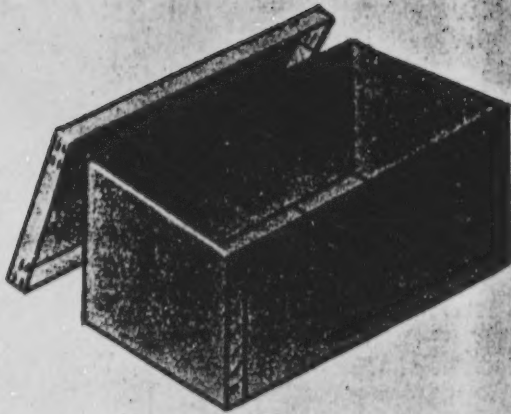


TRIPLE SLIDE BOX-TS

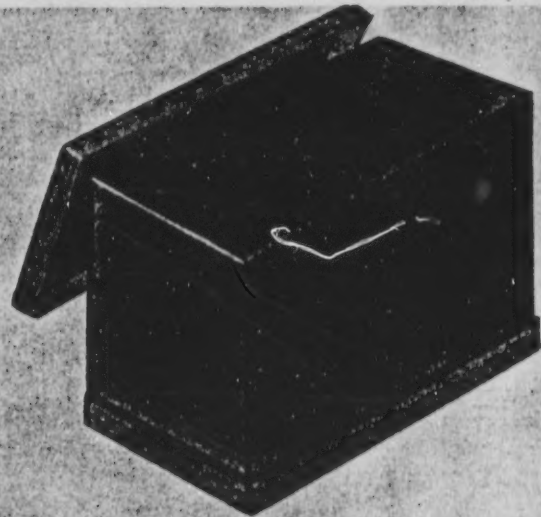
JMPTC 450

Figure 2-7. Styles of fiberboard boxes.

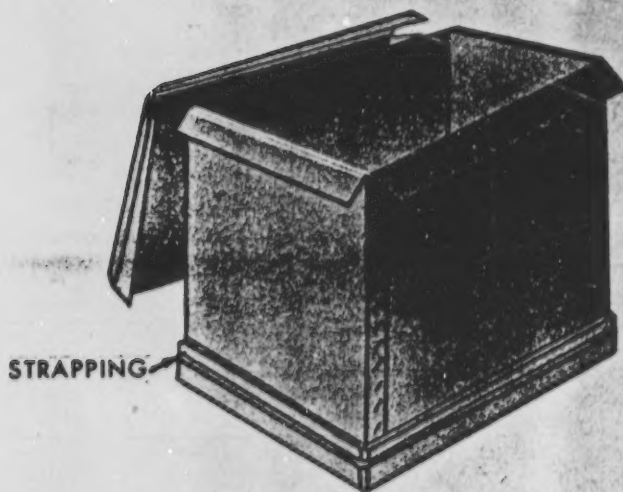
142



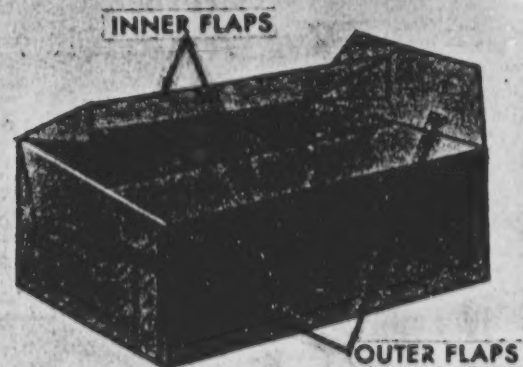
HALF SLOTTED BOX WITH COVER-HSC



DOUBLE-COVER BOX-DBLCC



INTERLOCKING DOUBLE COVER BOX-IC



DIAGONALLY SLOTTED BOX-DSC

JMPTC 2368

Figure 2-8. Styles of fiberboard boxes.

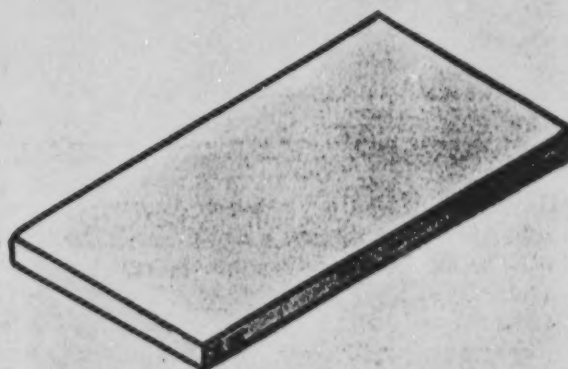
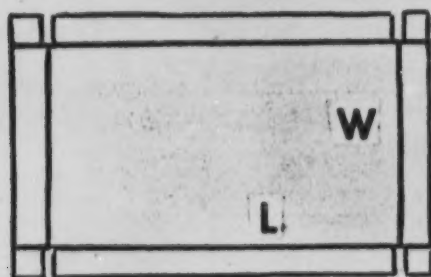
cause the inner flaps to overlap. In such a case, the inner flaps will be cut to meet in the center of the box.

(8) *OPF, one-piece folder*. When this box is closed, the outer flaps must meet. Unless otherwise specified, the inner flaps will not be less than 2 inches long for folders under 18 inches in width, and not less than 3 inches long for folders 18

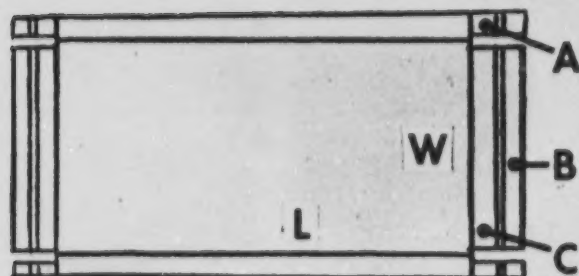
inches and over in width. This style is also known as a book wrapper.

(9) *TS, triple-slide box*. This design, made from corrugated fiberboard only, is identified by the arrangement of corrugations in which all corrugations run at right angles to the score lines in all parts of the box. It consists of three slides, each of one piece of corrugated fiberboard, scored so as to

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TYPE I STITCH LOCK



TYPE II FRICTION LOCK



TYPE III FLANGE INTERLOCK

JMPTC 2372

Figure 2-9. Cover assemblies.

cover completely four faces of the box. The joint of the inner slide will be left open. The middle slide will be taped at the body joint and will be a sliding fit on the assembled inner and outer slides. The outer slide will be taped at the body joint and will be a sliding fit on the assembled inner and middle slides.

(10) *FPF, five-panel folder*. This design consists of a single scored slotted sheet. When set up the outer end flaps will fully overlap. This box is used to an advantage in the packing of stacked or nested items which can be arranged on the flat scored sheet and when in position, the box is folded over the contents.

(11) *HSC, half slotted container with cover*. This box consists of a box body and a cover. The body is formed from fiberboard, scored, slotted, and stitched to form a tube having four flaps of equal length, approximately half the width of the box, on the bottom only. Unless otherwise specified the cover shall be a Type I (fig 2-9). When specified the cover shall be Type II. The depth of the cover is three inches unless otherwise specified.

(12) *DBLCC, double cover container*. This box consists of a body tube and two covers. Unless otherwise specified Type I covers, three inches deep, are to be used.

(13) *IC, interlocking double cover container*. This box consists of a body tube with top and bottom flanges and two interlocking covers. The body shall be SW or DW fiberboard, scored, slotted, and stitched to form a tube having double scored short flanges which form a lock with the

flanges of the cover (fig 2-9). The top and bottom covers shall be secured with horizontal straps. Unless otherwise specified the flanges shall be three inches wide for boxes made with single-wall fiberboard and four inches wide for boxes made with double-wall fiberboard.

(14) *DSC, diagonally slotted*. This box is constructed by scoring and slotting fiberboard to form a body piece having four flaps for a closing edge of two opposite faces. The flaps along the longer edge are the inner flaps and those along the shorter edge are the outer flaps. The flaps are of equal length when measured from the score line to the outer edge, and the inner flaps meet when closed. The body joint is along one of the four edges perpendicular to the open face. The angle of the slot in the flap area shall be not less than 60 degrees.

k. *Sleeves*. A sleeve may be specified for use with any of the box styles to provide added strength. Sleeves will be made from class weather-resistant fiberboard of the same type and grade as the box. A sleeve will closely fit the box over which it is placed and will cover the top bottom, and both ends. The length of the sleeve (length of the stapled joint) will be the same as the inside width of the box. Unless otherwise specified, the corrugations will be at right angles to the score lines (fig 2-10).

l. *Liners* (fig 2-11). Liners are made from one piece of fiberboard. They are scored to cover the end and side panels of the boxes. The height of the liners shall be the full inside depth of the boxes for

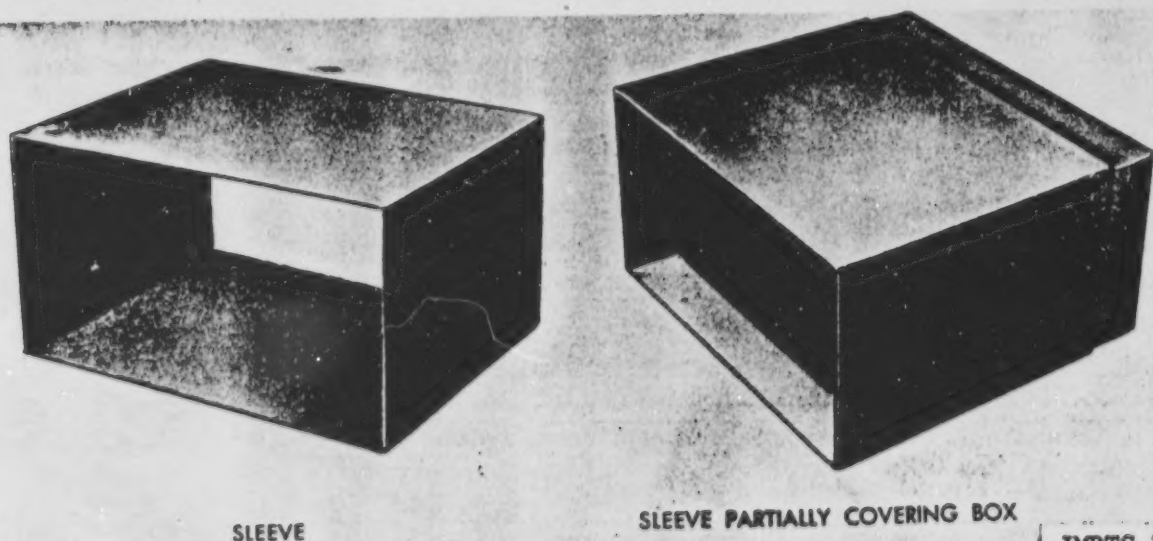
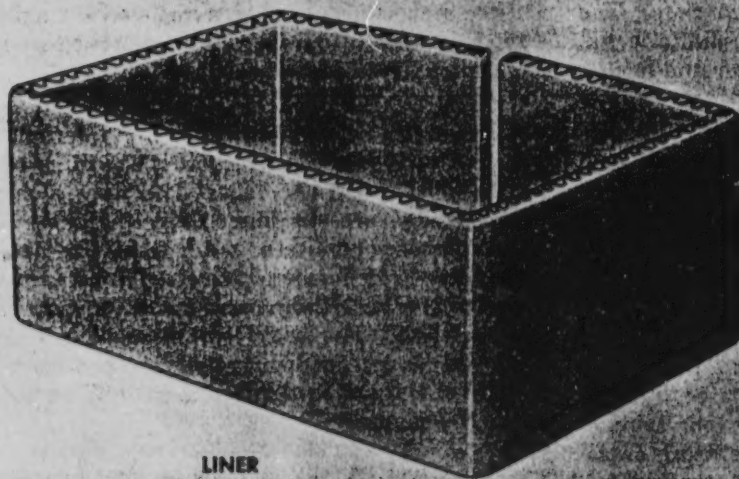


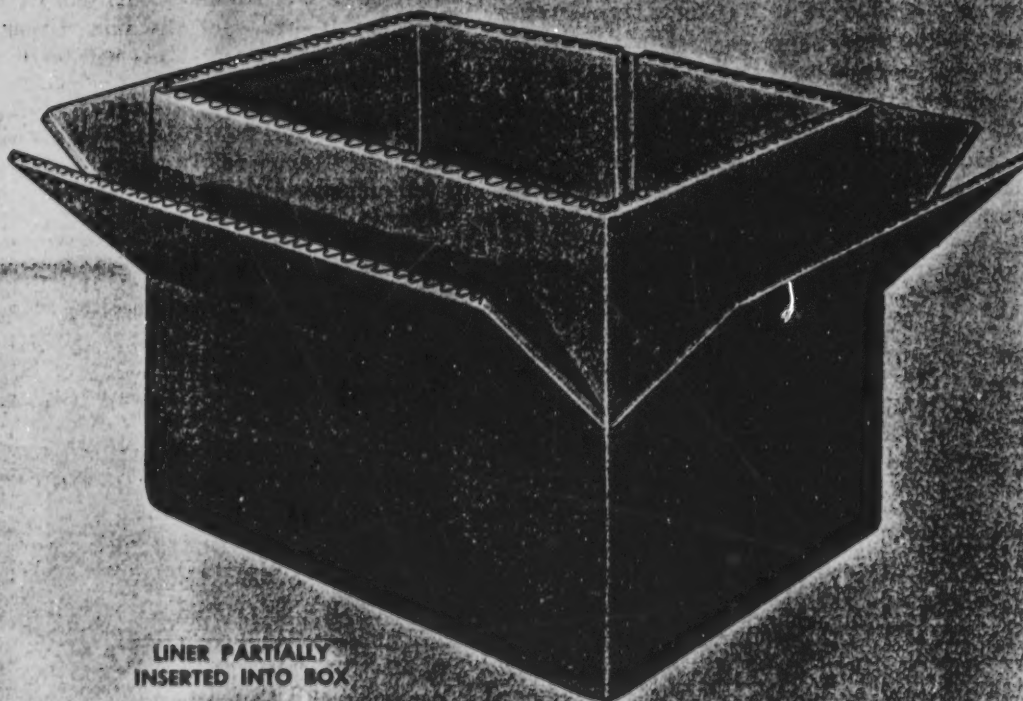
Figure 2-10. Use of a fiberboard sleeve.

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LINER



LINER PARTIALLY
INSERTED INTO BOX

Figure 2-11. Use of a fiberboard liner.

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which they are intended and the ends of the liners shall abut in the center of the side panels of the boxes.

(1) Unless otherwise specified liners for class domestic boxes shall be constructed of double-wall fiberboard, Grade 275. The joints shall be secured with minimum 2-inch wide tape conforming to Specification PPP-T-45, Type III.

(2) Unless otherwise specified liners for Class weather-resistant boxes shall be constructed of V15c fiberboard. When specified Grades W5c, W6c, V3c, or V13c shall be used. Liners fabricated from single-wall fiberboard shall be A or C flute and liners fabricated from double-wall fiberboard shall be any combination of A, B, or C flutes, except BB flutes shall not be used. The flutes shall be perpendicular to the box openings (as shown in fig 2-11). The joints shall be secured with minimum 2-inch wide tape conforming to Specification PPP-T-45, Type II, Class 2; PPP-T-60, Type IV; or PPP-T-76.

m. Box Maker's Certificate (fig 2-12). Each fiberboard box will be plainly marked with the box maker's certificate, signifying compliance with the requirements of the Uniform Freight Classification in effect on the date of invitation for bids. Type CF and type SF, class domestic boxes are not required to be marked as being in compliance with Specification PPP-B-636. However, there is no objection to marking boxes that are manufactured in compliance with the Specification. Types CF and SF, class weather-resistant boxes, in addition to the boxmaker's name, will be marked with the date of manufacture expressed in month and year, such as 1-74; the identification symbol, such as V3s; and the specification compliance data, including the revision letter, such as COMPLIES WITH SPECIFICATION PP-B-636H; and the minimum average bursting strength guaranteed in excess of . . . PSI. The figure to be inserted should be that corresponding to the dry mullen requirements in Specification PPP-F-320 for the particular grade of fiberboard used.

n. Closure Requirements. All boxes should be securely closed. Inner and outer flaps of slotted style boxes should be drawn together as closely as possible to insure proper closure. The lengthwise flaps should meet (RSC, CSSC, DSC) or overlap (OSC, CSOSC, FOL, SFF), as specified. The flaps should not project over the side or end edges, and the application of adhesive or metal stitches should be such as to prevent lifting of free edges and corners of outer flaps on assembled boxes.

(1) *Class domestic boxes.* Unless otherwise specified, these boxes will be securely closed by



BOXMAKER'S CERTIFICATE

1/76

V3 C

COMPLIES WITH SPEC.
PPP-B-636

MINIMUM AVERAGE BURSTING
STRENGTH GUARANTEED IN
EXCESS OF 400 LBS. P.S.I.

COMPLIANCE MARKINGS

JMPTC 218 J

Figure 2-12. Sample of box maker's certificate (circular).

Method I or Method II, below. When specified only Method II closure should be utilized. Method II closure is usually only utilized when specified because the containers reusability is affected when boxes are glued.

(a) *Method I.* Domestic fiberboard boxes should, as a minimum, be closed in conformance with the requirements of Rule 41 of the Uniform Freight Classification. When specified Method I

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Table 2-3. Basic Number of Stitches or Staples for Closing Weather-Resistant Slotted Fiberboard Boxes

Inside width of the box in inches	Basic number of stitches or staples 1-1/4 inch ¹	Basic number of stitches or staples 3/8 thru 1-1/4 inches ²
Up to and including.....		
8	8	12
10	10	16
12	12	20
14	16	24
15	18	28
18	20	32
20	22	36
22	24	40
24	28	44
28	30	48

¹ Staples or stitches hardened to not less than equivalent of Rockwell B90.² Not hardened to equivalent Rockwell B90.

closure may be used for boxes to be palletized or unitized for shipment where storage and redistribution is expected through the depot supply system.

(b) *Method II.* Domestic fiberboard boxes should be closed by the application of glue, or thermoplastic materials; or a combination of stitching or stapling one closure and gluing; or applying thermoplastic material to the final closure in accordance with Rule 41 of the Uniform Freight Classification. Taping of the closure is not permitted. Method II provides for definitive methods of closures for shipment where storage and redistribution is expected through the depot supply system.

(2) *Class weather-resistant and WWVR boxes (styles RSC, OSC, FOL, SFF, CSSC, CSOSC and DSC).* All weather-resistant and WWVR (fig 2-6, 2-7, and 2-8) fiberboard boxes should be closed by one of the following methods:

(a) *Method III.* The top and bottom flaps of slotted boxes should be firmly glued together over not less than 75 percent of the surface area of contact between the flaps (fig 2-13). The adhesive used should conform with the requirements of Specification MMM-A-250. The bottom flaps may be fastened with metal stitches or staples in lieu of gluing. The number of stitches to be used is based upon the inside width of the box in inches, and determined in accordance with table 2-3. When stitching the bottom flaps half of the stitches or staples will pass through each of the inner flaps and be distributed in such a manner as to fasten all flaps together over the entire area of contact between inner and outer flaps. This is to prevent the lifting of free edges and corners (fig 2-13). After packing, the other set of flaps (top of the box) is sealed with Specification MMM-A-250 adhesive in the same manner described for this method above.

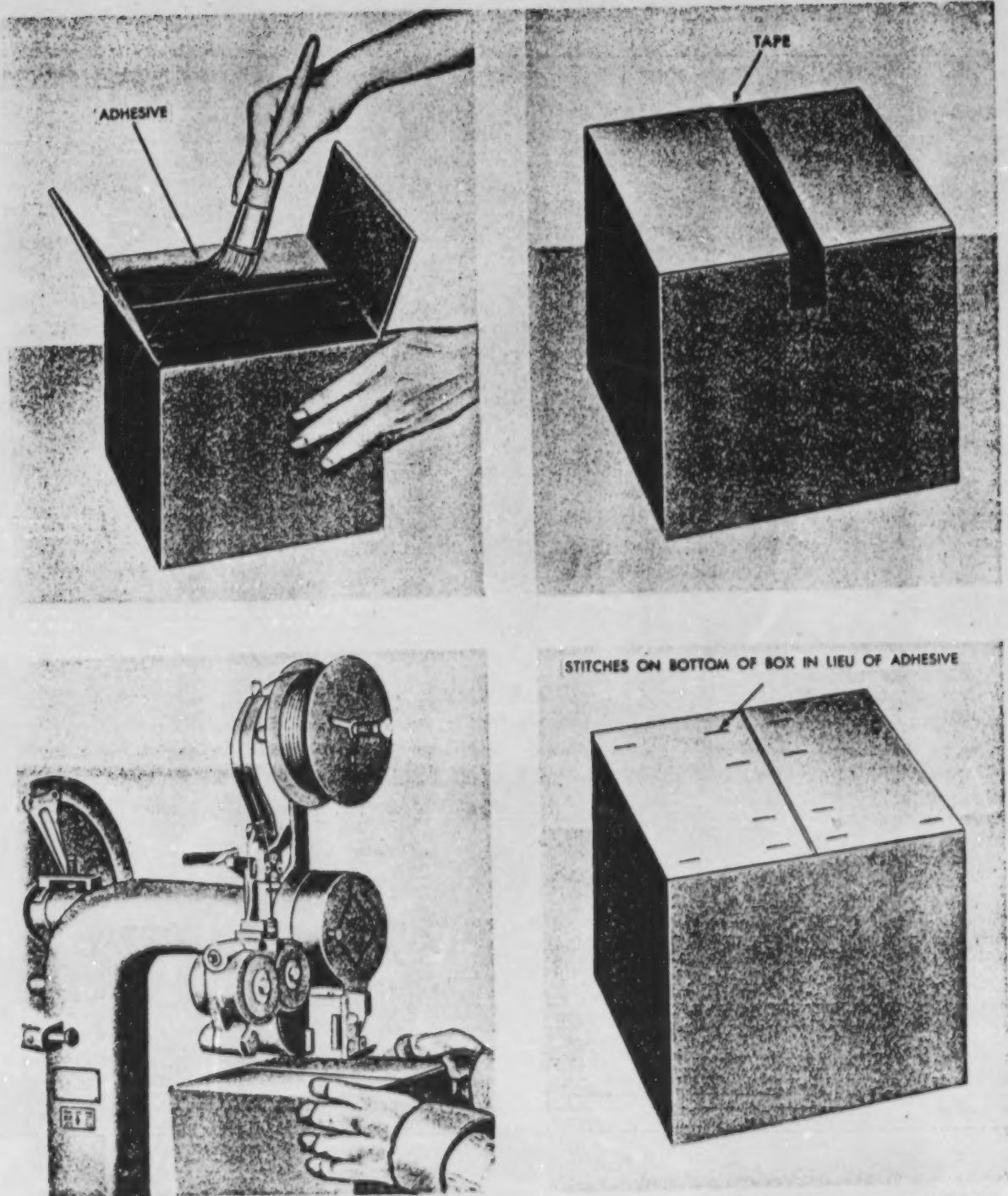
(b) *Method IV, Taping (styles RSC and CSSC) interior containers.* These styles, which are to be overpacked for shipment, may, unless otherwise specified, have the top and bottom flaps closed with 2-inch wide tape conforming to Specification PPP-T-76, or PPP-T-60, Type III or IV.

(c) *Method V, Taping (styles RSC, CSSC, and CSOSC) as exterior containers.* When specified, flaps of these styles of boxes shall be closed with tape applied over all seams, corners, and manufacturer's joint with minimum 2-inch wide tape conforming to Specification PPP-T-76 or PPP-T-60, Type III or IV. The tape shall be centered over the seams and joints and should extend over the corners and edges of the box a minimum of 2 inches onto the adjacent box panels. Tape shall be applied over the lengthwise seam of the outer flaps closing the opening of the box and over the manufacturer's joint prior to tape being applied to the edge seams of the box. The tape applied to the manufacturer's joint need only cover the joint and need not be extended over the corners of the box onto the adjacent panels.

(d) *Method VI, Hot melt.* When specified the flaps shall be closed in accordance with Method II for hot melt (thermoplastic).

(3) *Class weather-resistant and WWVR boxes (styles FTC, OPF, FPF, and TS).* All exterior full telescope, one-piece, folder, five-panel folder, and triple slide style boxes will be closed by taping all seams and joints with a minimum of 2-inch wide tape conforming to Specification PPP-T-60, Type III or IV, or PPP-T-76 (fig 2-14). Style C boxes may be closed by banding as specified in o(1) and (2) below.

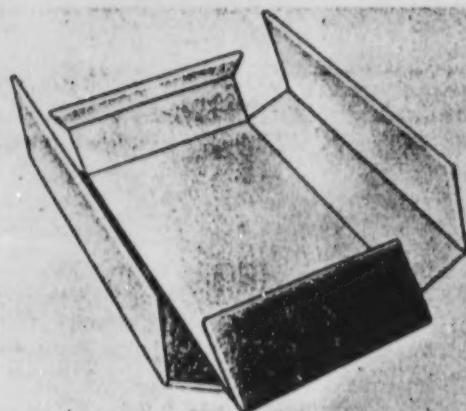
(4) *Class weather-resistant and WWVR boxes (style IC).* The top and bottom covers of the interlocking flange boxes shall be secured by flat strap



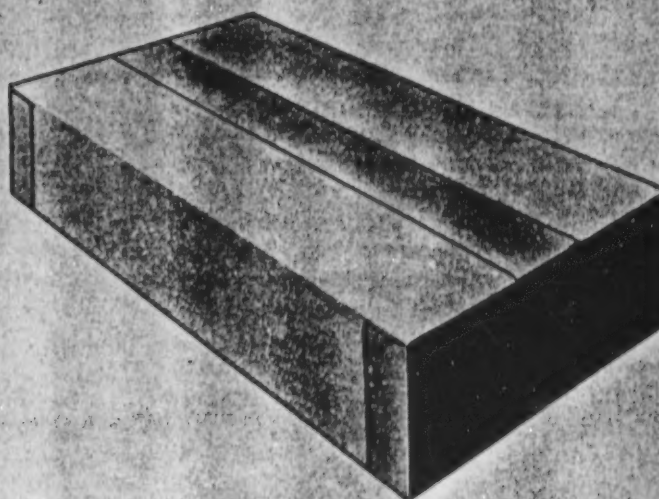
JMPTC 219 B

Figure 2-13. Closure of slotted glass weather-resistant fiberboard boxes with adhesive and/or stitches.

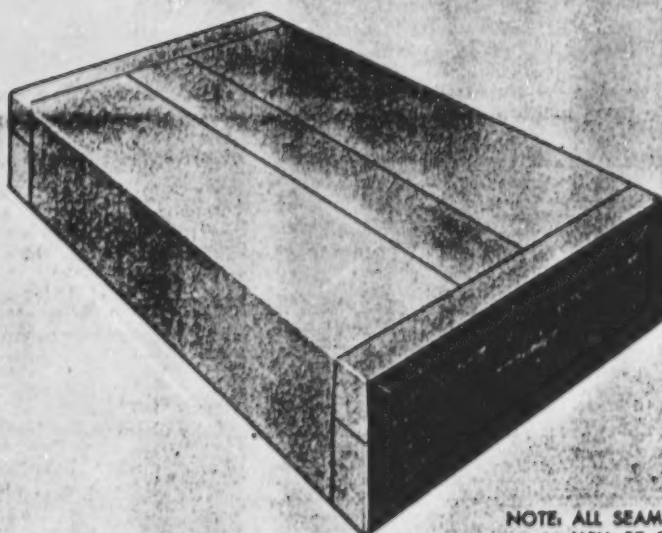
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ONE-PIECE FOLDER—OFF



TOP SEAM AND
CORNERS TAPED



ENDS TAPED

NOTE: ALL SEAMS AND JOINTS OF STYLES FTC, FPP, AND TS
WILL BE CLOSED IN A SIMILAR MANNER

AMPTC 453A

Figure 2-14. Closure of nonslotted class weather-resistant and WWVR fiberboard boxes with tape.

ping applied horizontally one bandwidth above the center line of the fold. The strapping shall be not less than $\frac{3}{8}$ by 0.015-inch, Class A or B, Grade 2, of Specification QQ-S-781 or Type II or III of Specification PPP-S-760.

(5) *Class weather-resistant and WWVR boxes (style DBLCC).* The covers may be secured by taping, tying, strapping, or gluing. When adhesive is used, the covers shall be glued firmly to the box bodies. When tape is used, it shall consist of encircling bands of pressure-sensitive adhesive, filament reinforced tape conforming to Type IV of Specification PPP-T-97. The width and number of tape bands to use will conform to the requirements of the appendix of Specification PPP-T-97. When metal or nonmetallic banding is used, it shall conform to the requirements of Specification QQ-S-781 or Type II or III of Specification PPP-S-760.

(6) *Class weather-resistant and WWVR boxes (style HSC).* This style shall have the bottoms secured as stated in (2)(a) above. The tops shall be secured by minimum 2-inch wide tape conforming to Specification PPP-T-60, Type III or IV or Specification PPP-T-76.

o. Reinforcing (Metal, nonmetallic, or tape banding) of Fiberboard Boxes (fig 2-15).

(1) *Class domestic boxes.* Unless specifically stated on the order or in the commodity specification, class domestic boxes will not be reinforced by the use of banding. When reinforcing is required, metal banding conforming to Specification QQ-S-781 or nonmetallic strapping conforming to Type I, II or III of Specification PPP-T-97 may be used. The size and number of metal strapping required shall be in accordance with tables 2-4, 2-5, 2-6 and 2-7. The size and number of nonmetallic strapping required is shown in table 2-8. Buckles shall not be used with nonmetallic strapping. The width and application of tape shall be in accordance with the requirements of the appropriate table and box style method of Federal Standard No. 224 (fig 2-16).

(2) *Class weather-resistant and WWVR boxes.* Class weather resistant boxes shall be reinforced by encircling bands of steel strapping conforming to Specification QQ-S-781 nonmetallic strapping conforming to Type II or III of Specification PPP-S-760; or pressure-sensitive adhesive, filament reinforced tape conforming to Type IV of Specification PPP-T-97, except when tape is used for perishable subsistence, type I, II, III or IV of PPP-T-97 may be used. The size of metal and nonmetallic strapping to be used is shown in table 2-4 for type, grade, and class required. The loca-

tion, number, and application metal and nonmetallic strapping is shown in tables 2-5 and 2-8. Buckles shall not be used on nonmetallic strapping. When tape is used to reinforce the box, it is applied in complete bands and the width shall be in accordance with table 2-9. Banding, including tape, shall not cover or obliterate markings on the shipping container. Unless otherwise specified shipping containers closed as specified in Method V (taping) must be reinforced by banding with tape or nonmetallic strapping.

(3) *Application of reinforcement.* When only one band is required on a box in a given direction, it shall be centered except in the case of lengthwise bands on styles RSC and CSSC boxes. On these styles the lengthwise band shall be offset slightly from the seam formed by the top and bottom flaps in the closed position. When two or more bands are used around the box in the same direction, they shall divide the box into units of equal length. Cross banded boxes shall have the longer band applied first. Boxes carrying loads having restricted points of contact shall be banded, wherever practicable, over these points of contact. Bands shall be applied straight and shall be sufficiently tensioned. Metal bands shall be embedded into the edges of the box, but shall not cut or tear the fiberboard or crush the contents. When a sleeve is specified the bands shall be applied after the sleeve is placed on the box.

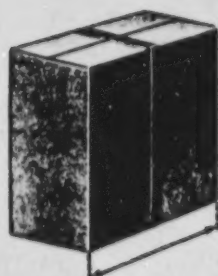
NOTE

Reinforcement may be omitted from class weather-resistant boxes containing nonperishable subsistence items and clothing which are to be palletized or containerized. An exception to this is nonperishable subsistence materiel consigned to the Naval Supply Center at Norfolk and Oakland for subsequent transfer at sea.

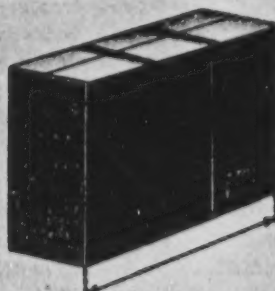
p. Reuse and Conservation of Fiberboard Boxes. It is important that attention be given to the reuse and conservation of fiberboard boxes. This must be looked upon from an economical standpoint. If care is used in opening incoming fiberboard boxes, some of them may be reused as interior or intermediate containers, but never as exterior shipping containers, with the exception of good V-board boxes. The condition of the box is a big factor in its reuse. No box that has been cut, torn, pierced, or damaged by water or moisture should be reused. If used, V-board boxes are included in this category, they may be reused for domestic shipments. Used boxes shall have all old markings pertaining to previous shipments oblit-

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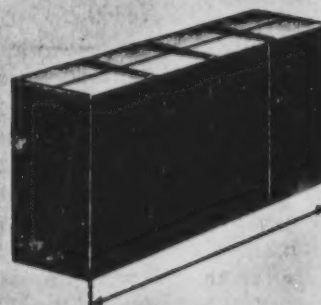
LENGTH OF BOX DETERMINES THE NUMBER OF GIRTHWISE STRAPS



LESS THAN 20



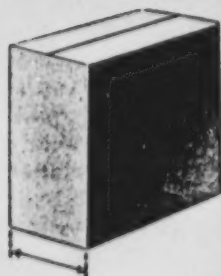
20 to 30



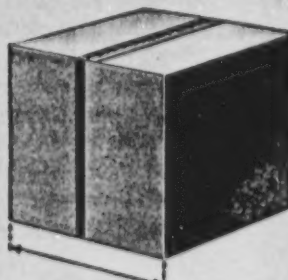
OVER 30 to 48

48 to 60—4 STRAPS
OVER 60—STRAP AS REQUIRED

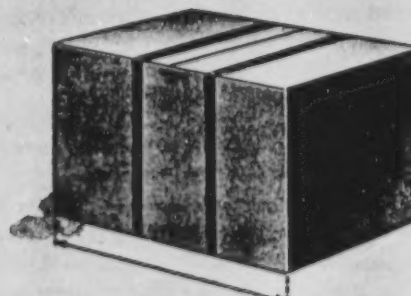
WIDTH OF BOX DETERMINES THE NUMBER OF LENGTHWISE STRAPS



LESS THAN 9



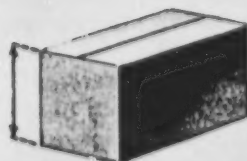
9 to 18



OVER 18 to 30

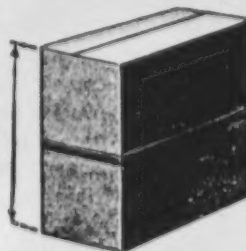
30 to 48—3 STRAPS
OVER 48—STRAP AS SPECIFIED

DEPTH OF BOX DETERMINES THE NUMBER OF HORIZONTAL STRAPS

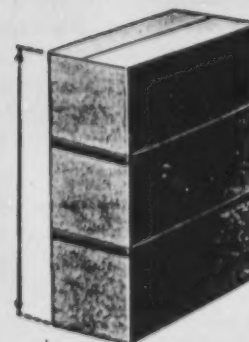


LESS THAN 18

OVER 48—STRAP AS SPECIFIED



18 to 30



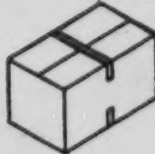
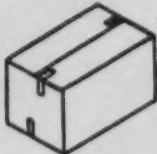
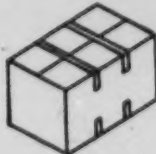
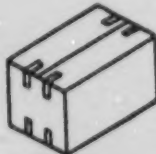
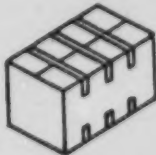
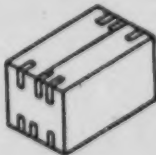
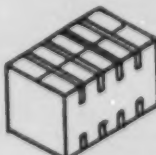
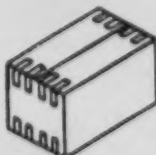
OVER 30 to 48

NOTE: ALL MEASUREMENTS SHOWN ARE IN INCHES.

JMPTC 221A

Figure 2-15. Strapping of fiberboard boxes.

MINIMUM NUMBER OF TAPE STRIPS WHICH MUST CROSS A SEAM OR SCORELINE

<u>LENGTH OF SEAM OR SCORELINE (INCHES)</u>	<u>NO. OF STRIPS</u>	<u>LENGTH</u>	<u>WIDTH</u>
UP TO 15 INCLUSIVE	1		
OVER 15 TO 30 INCLUSIVE	2		
OVER 30 TO 60 INCLUSIVE	3		
OVER 60	4		

JMPTC 445A

Figure 2-16. Tape Reinforcing of fiberboard boxes.

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Table 2-4. Metal and Nonmetallic Strapping Requirements

Gross weight of container and contents	QQ-S-781, size of flat steel strapping		PPP-S-760, size of nonmetallic strap			QQ-S-781 size (gage) of round steel strap	
Pounds	Type I	Type III	Type IV	Type II	Type III	Type V	Type VI
Upto 35, incl	1/4 x 0.015 5/16 x 0.012 3/8 x 0.010	0.138 x 0.025 0.063 x 0.024 ¹	1/4 x 0.015	3/8 x 0.015	7/16 x 0.017 1/2 x 0.015	16-1/2	16-1/2
Over 35 to 70, incl	3/8 x 0.015	0.138 x 0.025	3/8 x 0.015	3/8 x 0.015	7/16 x 0.017 1/2 x 0.015	16	15
Over 70 to 110, incl	3/8 x 0.020 1/2 x 0.015		3/8 x 0.020 1/2 x 0.015	1/2 x 0.015 3/8 x 0.020	1/2 x 0.015 7/16 x 0.017	14	13
Over 110 to 225, incl	1/2 x 0.020		1/2 x 0.020 5/8 x 0.015	1/2 x 0.020	7/16 x 0.017 1/2 x 0.020	13	12

¹ 0.063 x 0.024 inch strapping shall be allowed only for V2a sleeve boxes and shall conform to QQ-S-781 except that it shall have a tensile strength of 135,000 psi, a breaking strength of 205 pounds and a joint strength of not less than 170 pounds.

Table 2-5. Required Number of Reinforcing Bands

Lengthwise	Directions of bands ¹				
	Girthwise		Horizontal ²		
	Number of bands (min.) ³	Outside length of box	Number of bands (min.) ³	Outside depth of box	Number of bands (min.) ³
<i>Inches</i>		<i>Inches</i>		<i>Inches</i>	
Up to 9	None	Up to 20	1	Up to 18	None
Over 9 to 18	1	20 to 30, incl.	2	18 to 30, incl.	1
Over 18 to 30	2	Over 30 to 48	3	Over 30 to 48	2
Over 30 to 48	3	Over 48 to 60	4		
Over 48		Over 60 ⁴		Over 48 ⁴	

¹ Lengthwise—Encircling top, bottom, and ends. Girthwise—Encircling top, bottom, and sides. Horizontal—Encircling sides and ends.

Note that the location of the openings determines the designation of the panels, rather than normal storage position.

² Horizontal bands are only occasionally required. Where contents exert severe pressure on vertical score lines, they should be used.

³ Full telescope-style boxes, having corners not otherwise sealed to bodies, will usually require use of one or more additional bands, both lengthwise and girthwise when dimensions approach the upper range of the size brackets listed in above table. Additional bands, when required, will be specified by the procuring agency.

⁴ As directed by the procuring agency.

Table 2-6. Metal Straps Required for DBLCC, IC or HSC Boxes

Box length (inches)	Number of straps		
	Box width		
	0 inches to 18 inches	18 inches to 30 inches ¹	30 inches to 48 inches ²
0 to 20	2	3	4
Over 20 to 38	3	4	5
Over 38 to 56	4	5	6
Over 56 to 72	5	6	7
Over 72	6	7	8

¹ One centered lengthwise strap required.

² Two equally spaced lengthwise straps required.

Table 2-7. Required Number of Reinforcing Bands for Slotted and FTC Boxes

Direction of Bands ¹					
Lengthwise	Girthwise		Horizontal ²		
Outside width of box	Number of bands (min.) ³	Outside length of box	Number of bands (min.) ³	Outside depth of box	Number of bands (min.) ³
<i>Inches</i>		<i>Inches</i>		<i>Inches</i>	
Up to 9	None	Up to 20	1 ³	Up to 18	None
Over 9 to 18	1 ³	20 to 30, incl ..	2 ³	18 to 30, incl ..	1
Over 18 to 30	2 ³	Over 30 to 48	3 ³	Over 30 to 48	2
Over 30 to 48	3	Over 48 to 60	4		
Over 48 ⁴		Over 60 ⁴		Over 48 ⁴	

¹ Lengthwise—Encircling top, bottom, and ends. Girthwise—Encircling top, bottom, and sides. Horizontal—Encircling sides and ends. See figures for designation of top bottom, side, and faces. Note that the location of the openings determines the designation of the panels, rather than normal storage position.

² Horizontal bands are only occasionally required. When contents exert severe pressure on vertical score lines, they should be used.

³ Full telescope-style boxes, having covers not otherwise sealed to bodies, will usually require use of one or more additional bands, both lengthwise and girthwise when dimensions approach the upper range of the size brackets listed in above table. Additional bands, when required, will be specified by the procuring agency.

⁴ As directed by the procuring agency.

Table 2-8. Size of Nonmetallic Banding (Minimum)

Gross weight of box and contents	PPP-B-760, Type I, grade A ¹	
Pounds	Size in inches	Number and position of bands
0 to 70	1/4	1 girthwise (centered)
Over 70 to 110	3/8	2 girthwise ²
Over 110 through 225	1/3	2 girthwise ²

¹ Type II or III nonmetallic strapping of PPP-B-760 of equivalent strength may be substituted for the type I, grade A.

² Bands shall divide box into units of equal length.

Table 2-9. Tape Banding Requirements for Weather Resistant Boxes

Gross weight of container and contents	Number of bands and sizes in inches							
Pounds	1	2	3	4	5	6	7	8
Up to 35 inclusive	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 35 up to 70 inclusive	3/4	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Over 70 up to 110 inclusive	1	3/4	3/4	1/2	1/2	1/2	1/2	1/2
Over 110 up to 140 inclusive	1	1	3/4	1/2	1/2	1/2	1/2	1/2
Over 140 up to 180 inclusive		1	1	3/4	1/2	1/2	1/2	1/2
Over 180 up to 220 inclusive			1	1	3/4	3/4	1/2	1/2
Over 220				1	1	1	3/4	3/4

erated before reuse as interior or exterior containers. If the whole boxes cannot be reused, consideration should be given to the use of clean, sound fiberboard as material for one of the following applications:

(1) Fabrication of blocks and braces to prevent movement of the item within the container, contact of items among themselves (when more than one is packed in a shipping container), or contact of an item with the faces of the container.

(2) Fabrication of die-cuts, cells, trays, pads, etc., for cushioning purposes.

2-2. Triple-Wall Corrugated Fiberboard Boxes (PPP-B-640)

a. *Description and Characteristics.* A triple-wall corrugated fiberboard box is a container made of triple-wall corrugated fiberboard in accordance with Specification PPP-B-640. Triple-wall corrugated fiberboard consists of three corrugated sheets laminated to four flat facings (fig 2-3) resulting in a thick, relatively sturdy structural material. Boxes made of this material have the following characteristics:

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(1) They are especially suited for difficult, heavy loads that require exceptionally large containers.

(2) They are extremely resistant to sudden forces such as those encountered when the box is dropped.

(3) They have a high resistance to compression and can sustain heavy loads for long periods of time.

(4) They are lighter in weight and smaller in cube than wooden containers made for the same items.

(5) They have certain inherent cushioning characteristics due to the corrugated stock from which they are made.

b. Classes and Styles. Triple-wall corrugated fiberboard boxes are furnished in the following classes, styles, and types of ends:

(1) *Class 1*—Nonweather-resistant.

(2) *Class 2*—Weather-resistant.

(3) *Style A*—One-piece fiberboard, five-panel, with one of four types of ends (*c* below), and with ends inserted in box body (fig 2-17).

(4) *Style B*—One-piece fiberboard, five-panel, with one of four types of ends (*c* below), with ends inserted in box body overlapped on the box ends (fig 2-17).

(5) *Style C*—Two-piece, fiberboard, three-panel, with one of four types of ends (*c* below), and with ends inserted in box body (fig 2-17).

(6) *Style D*—Two-piece, fiberboard, three-panel, with one of four types of ends (*c* below), and with ends inserted with outside edges of the box body overlapped on box ends (fig 2-18).

(7) *Style E*—A regular slotted fiberboard box (para 2-1), conforming to Style RSC of Specification PPP-B-636. The body (manufacturers' joint should be 2 inches wide, crushed, and stapled on a slant not more than 1 inch apart (fig 2-18). The corrugations of that portion of the side panel in which the body joint overlaps shall also be crushed. Style E boxes may also be made with a 1½-inch crushed overlap on the top and bottom panels of the box. This is called an alternate Style E box.

(8) *Style F*—A full telescopic fiberboard box (para 2-1), consisting of a body and a cover each of one-piece slotted and scored triple-wall fiberboard. The inside depth of the cover shall be the overall depth of the body (fig 2-18).

(9) *Style G*—Half regular slotted box with short top flaps and cover. Style G box is similar to Style F, except that all the top flaps are 4 inches

long and are crush-rolled 1½ inches at the edges. A cover, at least 6 inches deep, forms the top of the container. The cover may be constructed so that the end and side flanges form a butt joint at each of the four corners (fig 2-19), or it may be made with end or side flaps which are stapled to the adjacent flange of the top.

c. Woods Ends. There are four types of wood or wood-cleated panel ends that can be used on Styles A, B, C, and D triple-wall corrugated fiberboard boxes. The wood used to fabricate the ends must conform to wood Groups I and II as set forth in Specification PPP-B-621 and Military Standard MIL-STD-731. The ends are of the following designs (fig 2-20):

(1) *Number 1 end*—A single piece of nominal 2-inch lumber.

(2) *Number 2 end*—Two thicknesses of nominal 1-inch lumber with the grain direction at right angles, the two thicknesses securely joined by clinched nails, and no piece less than 2½ inches in width.

(3) *Number 3 end*—Nominal 1-inch material with a nominal 1-inch thick cleat minimum width of 2¼ inches, securely joined by clinched nailing.

(4) *Number 4 end*—Cleated panel ends consisting of two sets of overlapped cleats with a panel of triple-wall corrugated fiberboard. The cleats shall be nominal 1 inch thick, 2¼ inches wide, and shall be assembled with clinched nailing. The fiberboard shall be fastened to the inside of the cleats with either nails or staples.

d. Limitations. Maximum weight and size limitations for triple-wall corrugated fiberboard boxes are not given in Specification PPP-B-640. When triple-wall corrugated fiberboard boxes are to be used for commodities covered in Rule 41 of the Uniform Freight Classification, the sum of the inside length, width, and depth shall not exceed 120 inches. Containers exceeding these limitations must be made under a special package permit.

e. Sealing. When sealing against the entry of water or dust is required, all seams and joints of the boxes shall be covered with minimum 2-inch tape conforming to Specification PPP-T-76. Closure of slotted boxes is frequently done prior to sealing.

f. Closure. The kinds of closure for triple-wall corrugated fiberboard boxes will depend on the style of box to be used, and may be made by means of nails, staples, steel straps, filament-reinforced tape, or a combination of these materials. When nails are used for closure or for fastening blocking and bracing members to the interior

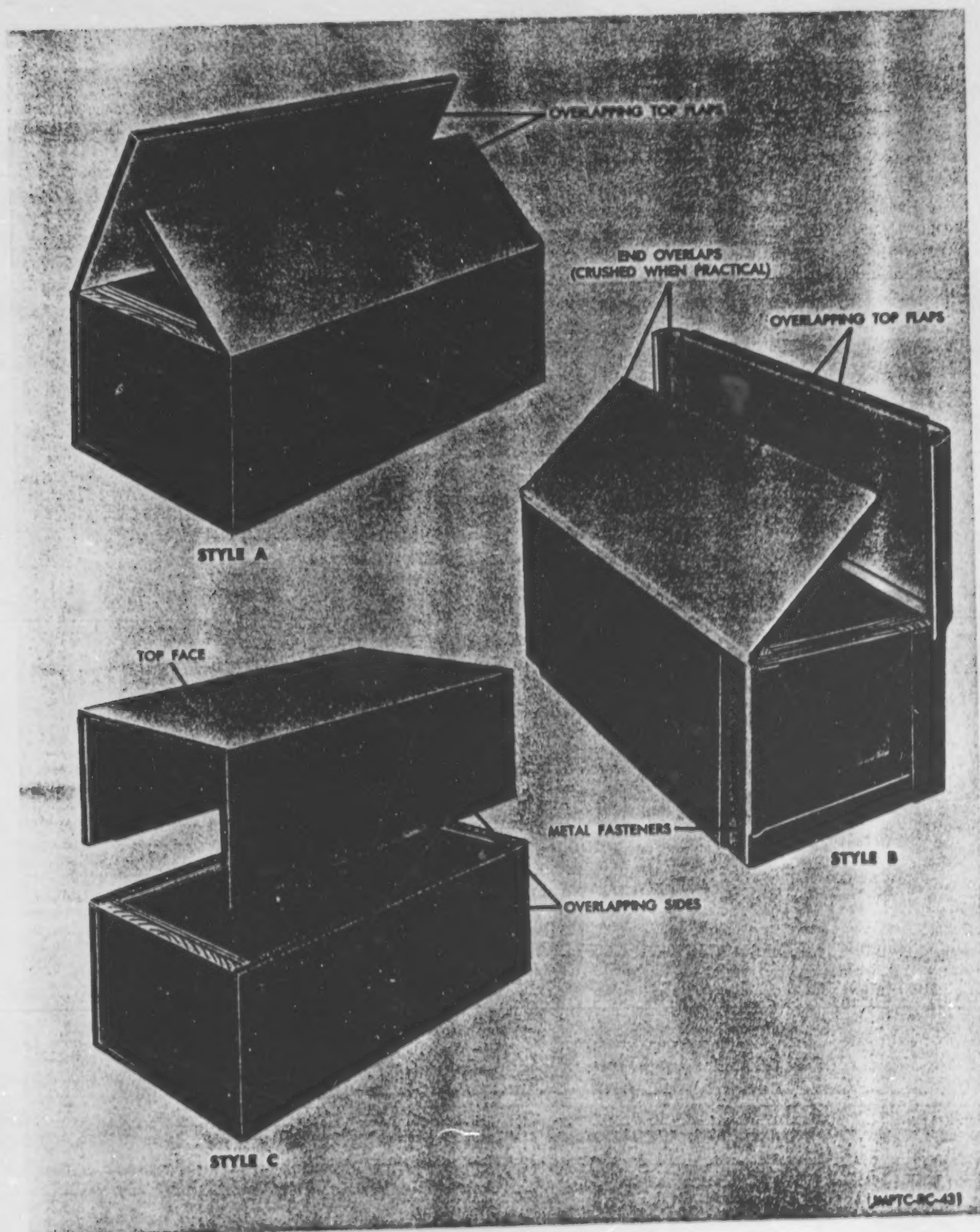


Figure 2-17. Styles A, B, and C, triple-wall corrugated fiberboard boxes.

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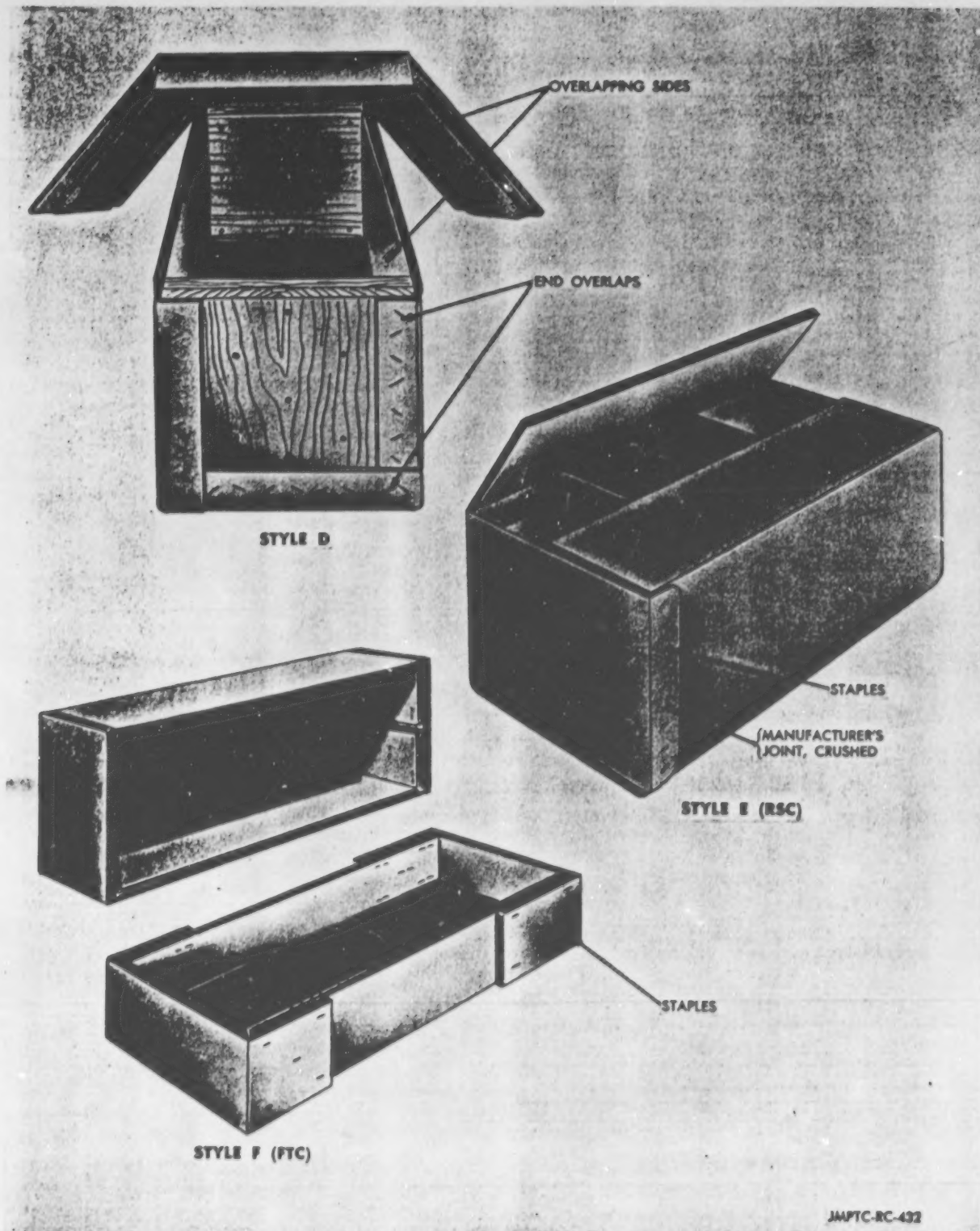


Figure 2-18. Styles D, E, and F, triple-wall corrugated boxes.



Figure 2-19. Style G, triple-wall corrugated fiberboard box.

of the boxes, it is recommended that each nail should pass through an oversize washer, piece of banding, or clips designed to prevent pulling of the nail heads through the triple-wall material.

(1) *Closure of style A boxes.* This style may be closed with zinc-coated, steel roofing nails not less than $1\frac{1}{4}$ inches long; with power driven, double pointed zinc-coated or copper-washed staples, with divergent points and minimum dimensions of 14-gauge wire, $\frac{3}{4}$ -inch crown, and $1\frac{1}{4}$ -inch legs; with flat, Type I, Class A or B, $\frac{5}{8}$ -inch wide and 0.018-inch thick steel straps conforming to Specification QQ-S-781; with round strapping conforming to Specification QQ-S-781 or with nonmetal strapping in accordance with Specification PPP-S-760, Type I or II (when Type I is used it shall be Grade B) with a nominal width of $\frac{5}{8}$ inch; or with pressure-sensitive, filament-reinforced tape meeting the requirements of Specification PPP-T-97, Type III, $\frac{1}{2}$ -inch wide, except for Styles E and F, which shall be 1 inch wide. On weather-resistant boxes, the PPP-T-97 tape shall be Type IV, $\frac{3}{4}$ -inch wide, except for Styles E and F, which shall be 1 inch wide.

(a) *Using nails for closure of style A boxes.* When nails or staples are used, they shall be spaced not more than 2 inches apart and staggered as permitted by the thickness of the ends of the box. The nails or staples shall extend through

each thickness of fiberboard and into the wood ends. If the box is 24 inches long, a strip of filament-reinforced tape shall be placed at the center of the outside top flap so as to extend onto the top flap 5 inches and onto the side panel 5 inches. For length greater than 24 inches, one such strip will be added for each additional 18-inch increment of length greater than 24 inches. The total number of strips will be spaced evenly (fig. 2-21).

(b) *Using straps for closure of style A boxes.* When steel or nonmetal straps are used, one band will be placed at each end of the box to encircle the top, sides, and bottom of the box. The straps will be placed not more than 3 inches in from the ends to bear evenly on the wood ends. If the box is 24 inches long, a strap will be added at the center. Filament-reinforced tape may be used in lieu of this additional strap. For lengths greater than 24 inches, one such strap will be added for each additional 18 inches of length and placed so that they are evenly spaced (fig. 2-21).

(c) *Using tape for closure of style A boxes.* When filament-reinforced tape is used, a 10-inch strip will be placed 2 inches in from each end of the box. For boxes 24 inches long and over, additional strip requirements are the same as for steel strapping. All the tape strips will be applied perpendicular to the joint formed by the top flap and

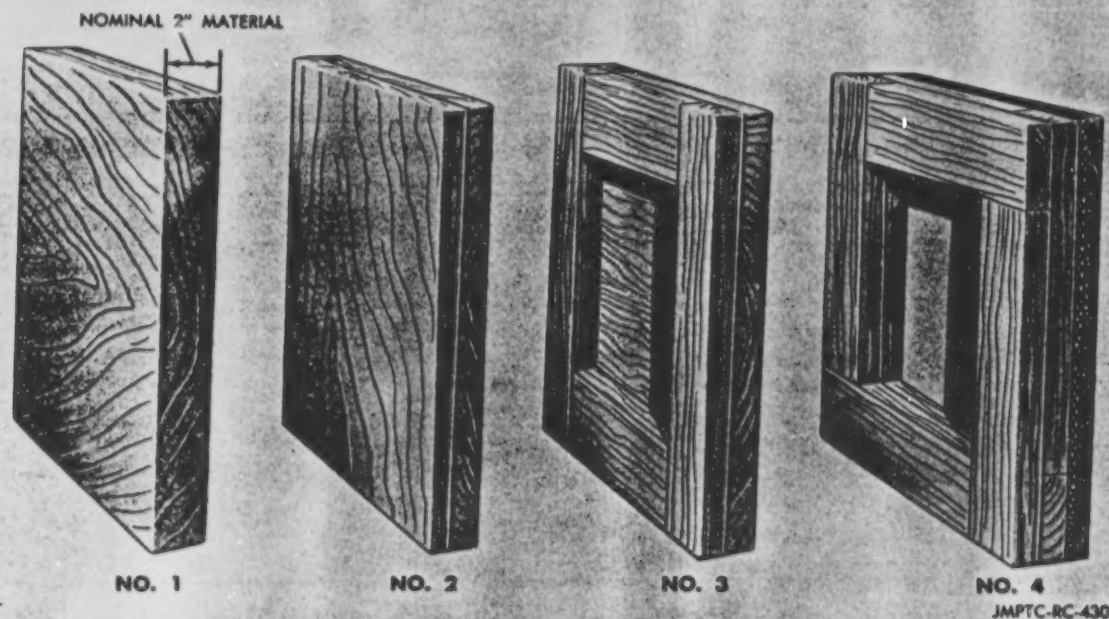


Figure 2-20. Types of ends for styles A through D, triple-wall corrugated fiberboard boxes.

the side wall of the box. They will be centered over the joint and extend 5 inches onto the top flap and 5 inches on the side wall (fig 2-21).

(2) *Closure of style B boxes.* Style B boxes may be closed with nails or staples in the same manner as Style A boxes; but, in addition, a staggered row of nails or staples, spaced not more than 2 inches apart, must be driven through the overlap portion of the top flap into the face of the wood ends. When using steep straps or filament-reinforced tape for closure, the same requirements as given for Style A boxes also apply to Style B (fig 2-21).

(3) *Closure of style C boxes.* This style of box will be closed along the top and sides by means of nails, staples, or steel straps as specified for Style A boxes, except when using nails or staples they will be spaced not more than 2 inches apart and staggered and driven through the top one-half of the box into the wooden ends along the two end edges of each side panel and both end edges of the top panel (fig 2-22).

(4) *Closure of style D boxes.* This style of box shall be closed along the top and sides by means of nails, staples, or steel straps as specified for Style A. In addition, a staggered row of nails or staples shall be driven through the overlapping top flaps into the face of the wooden ends. For boxes 24 inches long and longer, strips of tape will be applied as for style A box (fig 2-22).

(5) *Closure of style E boxes.* Style E boxes may be closed by the use of staples, steel or nonmetallic strapping, or with tape.

(a) *Closure with staples.* Staples will not be used for boxes fabricated with class weather-resistant fiberboard. Staples are placed not more than $1\frac{1}{2}$ inches, or less than 1 inch, from the free edge of the flap. Spacing around the edge of each flap is not more than 5 inches, center-to-center of the staples. Additional staples are so spaced within the boundaries outlined by the edge staples so that no area will have a diameter greater than 4 inches without a staple, with a minimum number of eight staples in each flap. Staples are flat wire, 0.050 inch thick, 0.085 inch wide, with a $1\frac{1}{4}$ -inch crown (fig 2-23).

(b) *Closure with metal or nonmetallic strapping.* The requirements for closure with strapping is the same as for style A boxes, except that a lengthwise strap may be applied to hold the girthwise strap flat (fig 2-24).

(c) *Closure with tape.* A 12-inch strip is applied to each end of the two top and bottom flaps so that 6 inches of each strip is attached to the flap and 6 inches of each strip is attached to the end panel. The strips are located adjacent to the inner length edge of the flaps, approximately 2 inches from this edge. The use of additional strips will be as specified for style A boxes.

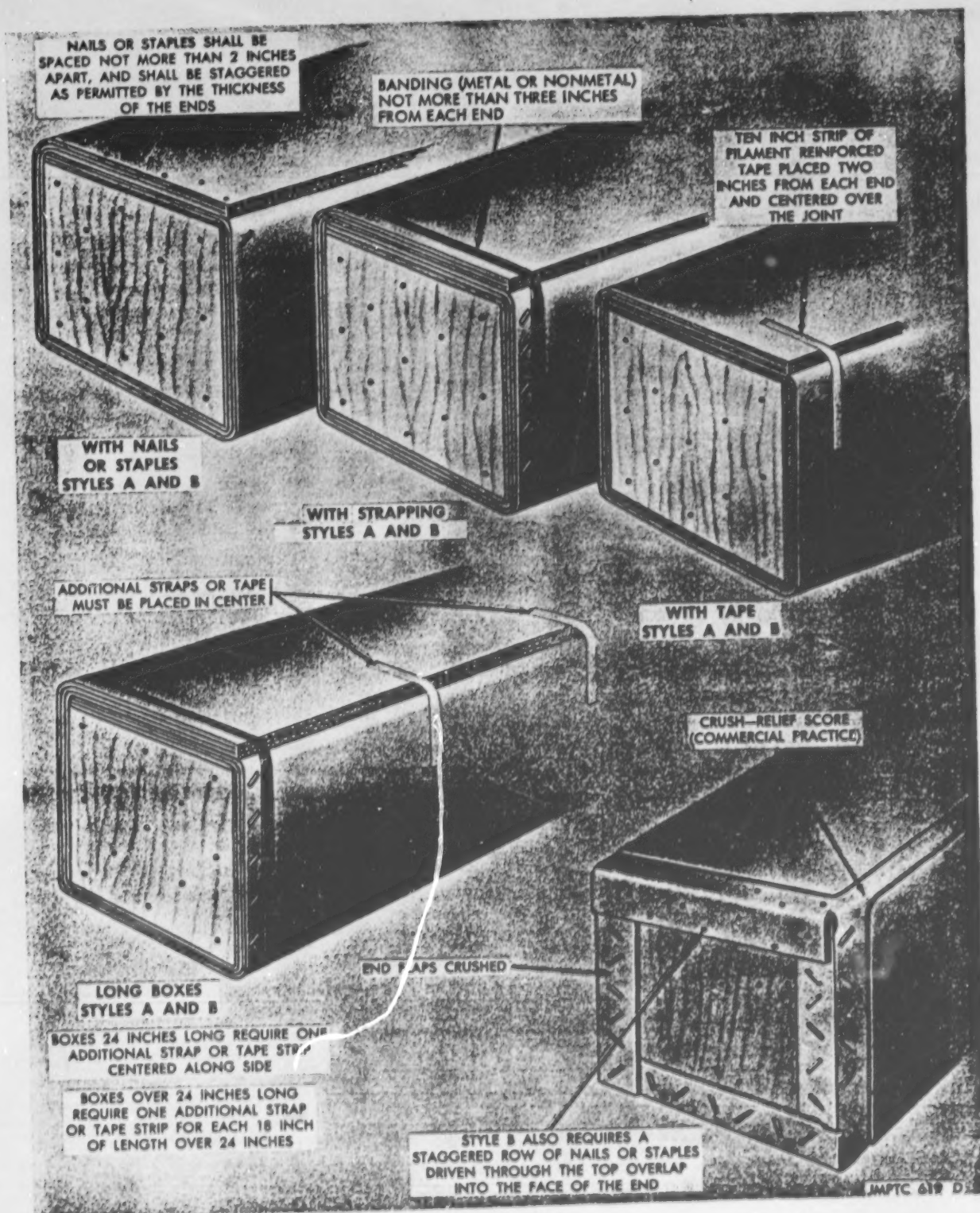


Figure 2-21. Closure of styles A and B, triple-wall corrugated fiberboard boxes.

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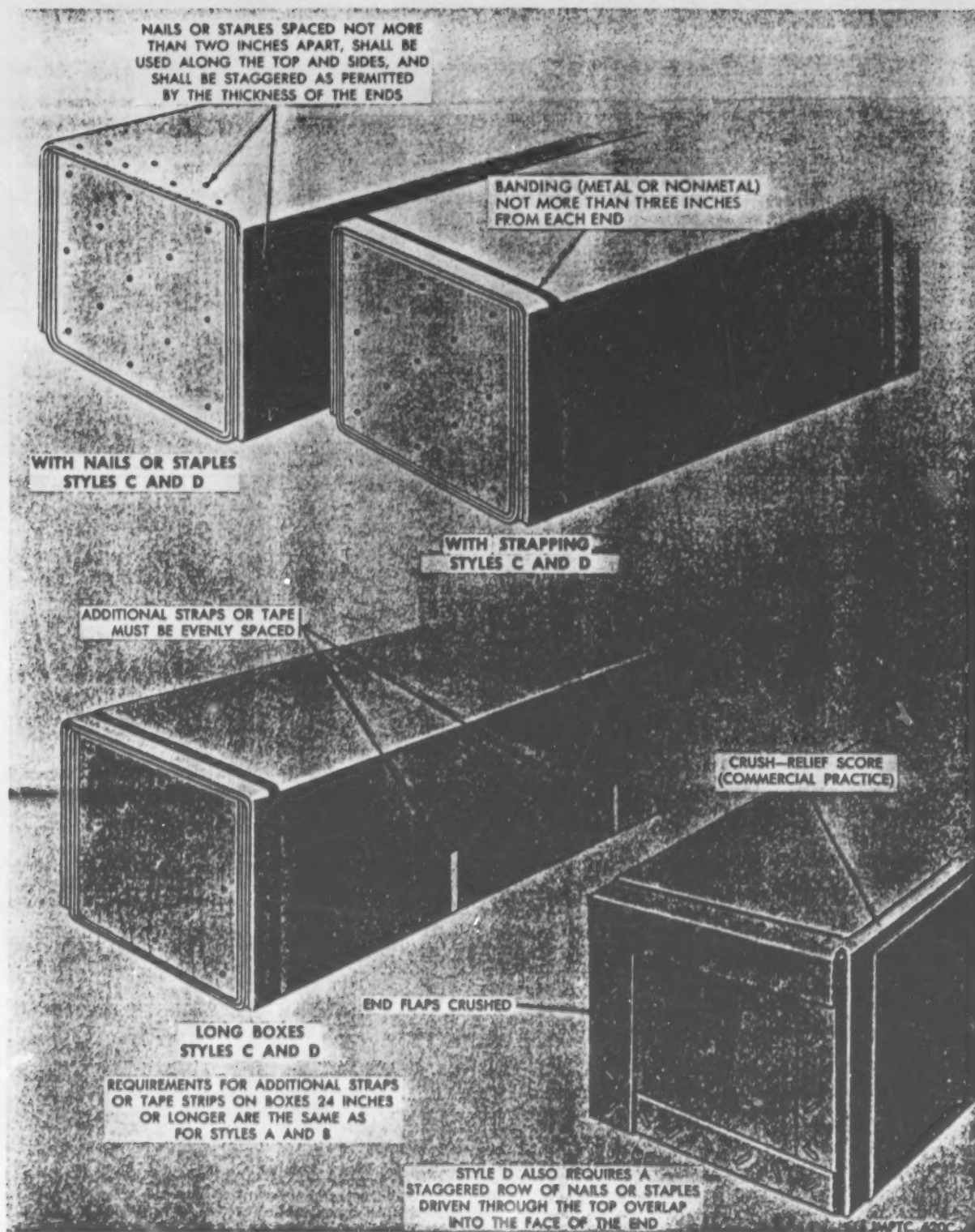


Figure 8-22. Closure of style C and D, triple-wall corrugated fiberboard boxes.

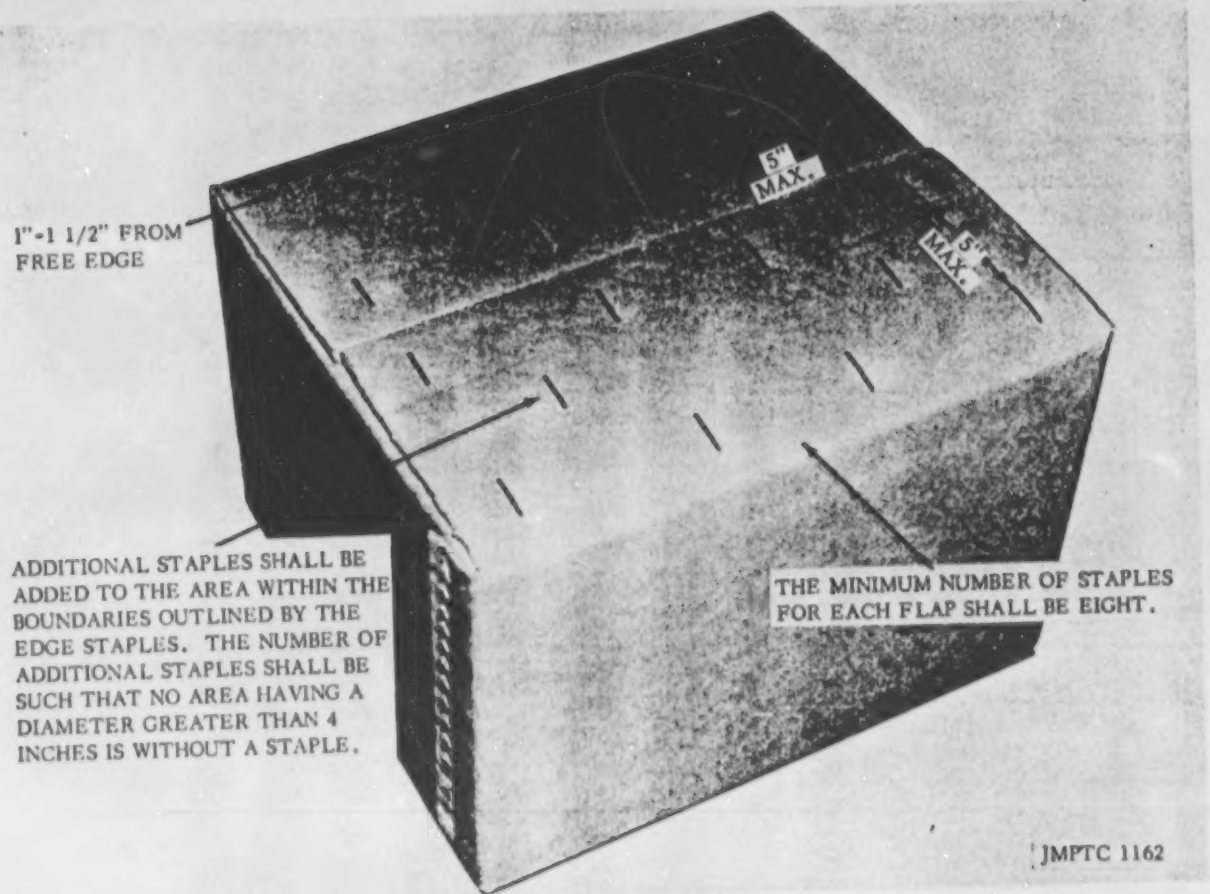


Figure 2-23. Stapling requirements for closure of style E, triple-wall corrugated fiberboard boxes.

(6) *Closure of style F boxes.* This style may be closed with steel or nonmetallic straps or filament-reinforced tape. When straps are used, they will be applied as described for style E boxes. When tape is used, one strip will be used on each side and each end. The strips will be not less than 12 inches long and will be applied at the center of the side and end panels and extend to the bottom of the box. When the length of the box is 24 inches, an additional strip will be added to each side and the two will be evenly spaced. Additional strips will be added for each 18-inch increment of length greater than 24 inches. Similar additional strips as required for length will be added to the ends when the box is 24 inches or greater in width (fig 2-25).

(7) *Closure of style G boxes.* When this box is used in conjunction with a pallet, closure and sealing will be as specified by the procuring activity. Without a pallet, style G boxes will be closed with straps. One strap will be centrally located around the top, ends, and bottom. Two straps will

be applied around the top, sides, and bottom, at a distance from the ends equal to three-fourths the length of the inner bottom flaps. If the distance between the straps exceeds 24 inches, additional straps will be spaced not more than 24 inches apart (fig 2-26).

2-3. High Compression Strength, Weather-Resistant, Wax-Resin Impregnated, Corrugated Fiberboard Boxes (PPP-B-1163)

a. *Description and Use.* These boxes are made of single-wall and double-wall fiberboard which are impregnated with a wax-resin composition to increase their wet strength. They are intended primarily for use where high stacking strength is desirable, when the ultimate handling atmosphere is moisture-laden, when the products are iced or wet packed, and when uncovered storage conditions may be encountered.

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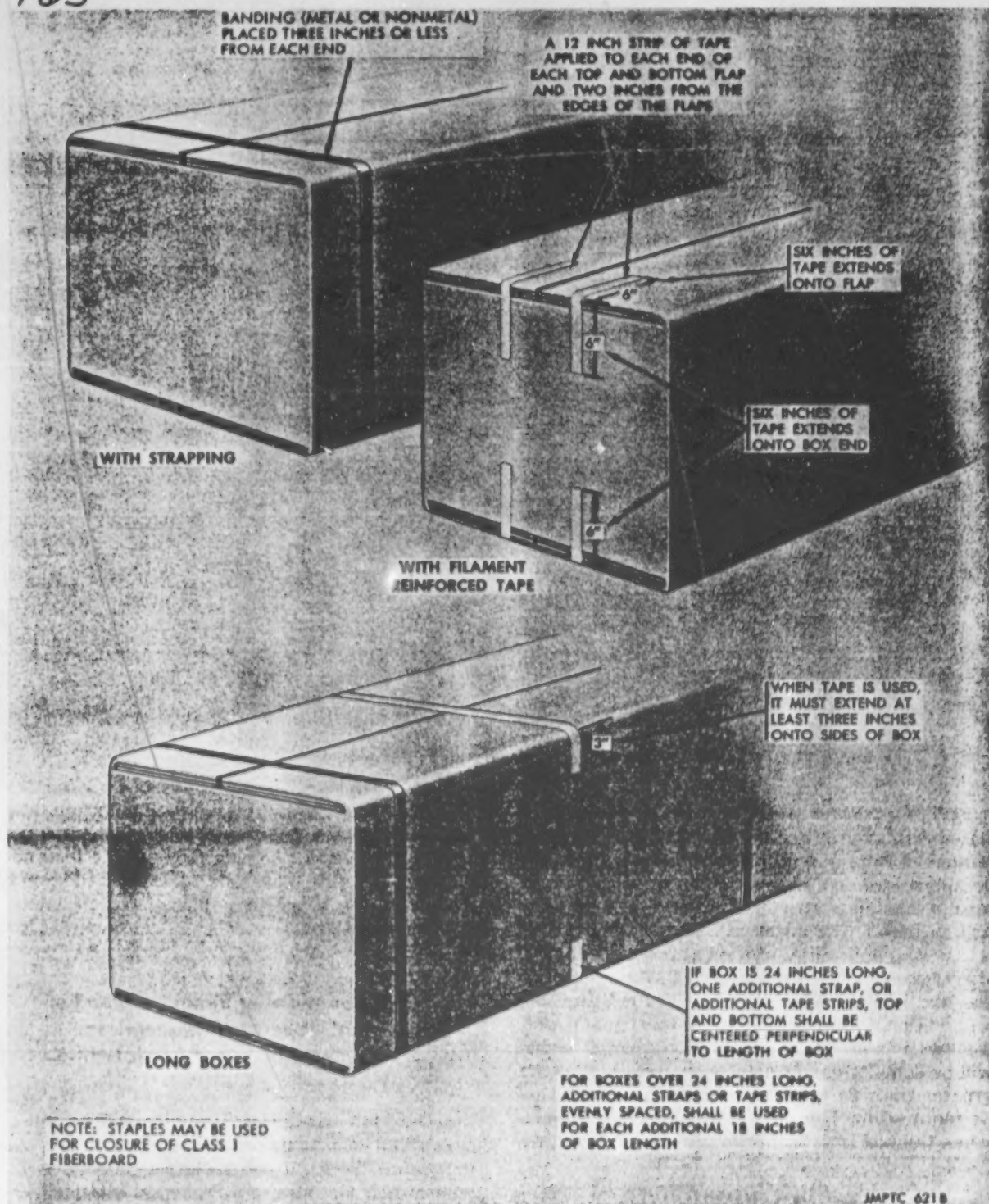


Figure 2-24. Closure of style E, triple-wall corrugated fiberboard box.

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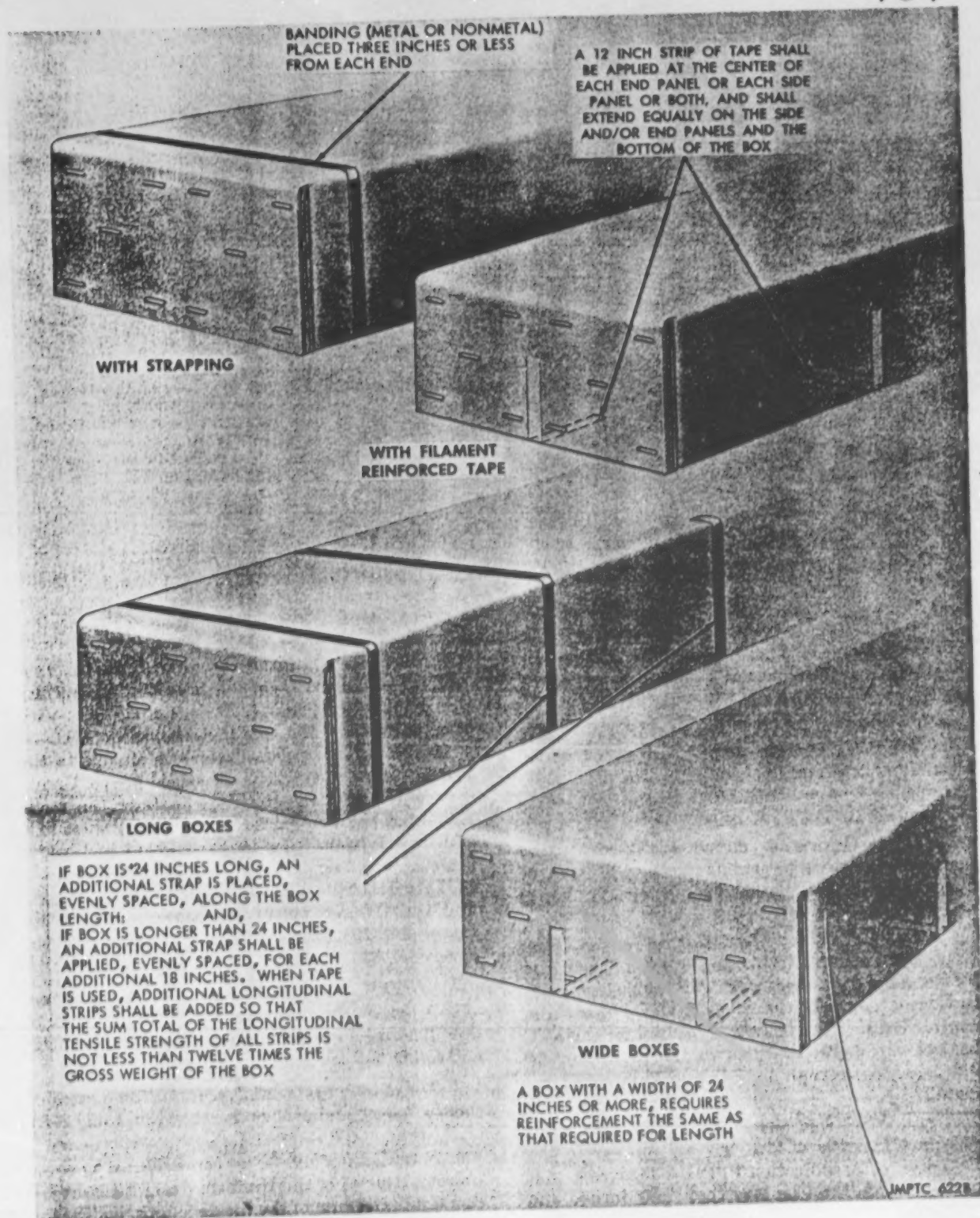


Figure 2-25. Closure of style F, triple-wall corrugated fiberboard box.

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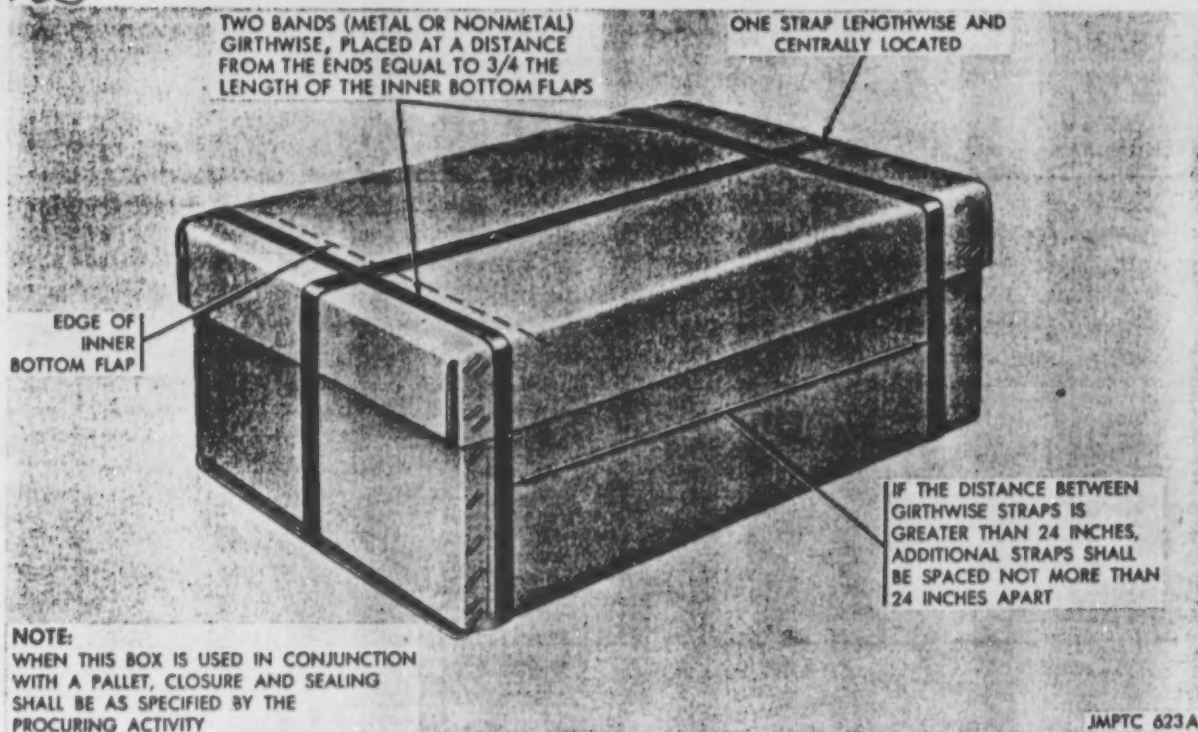


Figure 2-26. Closure of style G, triple-wall corrugated fiberboard box.

b. *Classification.* These boxes are available in seven styles, two classes, two types, and nine grades.

(1) *Styles.*

(a) *RSC, regular slotted box.* Construction features of this box are similar to the RSC style box of Specification PPP-B-636. See paragraph 2-1j(1) and figure 2-6 for details.

(b) *OSC, overlap slotted box.* Construction features of this box are similar to the OSC style of Specification PPP-B-636. See paragraph 2-1j(7) and figure 2-7 for details.

(c) *TC, telescope box, full or partial.* Construction features of this box are similar to the FTC style of Specification PPP-B-636, except that the inside depth of the cover shall be either the overall depth of the body, as required for the FTC box, or the depth specified in the invitation for bids. See paragraph 2-1j(4) and figure 2-6 for details.

(d) *HSC, half-slotted box with cover.* Construction features of this box are similar to the HSC style of Specification PPP-B-636, except that the cover shall not be less than four inches and the overlapping flaps must be secured with at least five staples. See paragraph 2-1j(11) and figure 2-8 for details.

(e) *HSCS, half-slotted box with flanged tube and cover.* Construction features of this box are similar to the Type III, Style 4, half RSC with telescope sleeve and cap of Specification MIL-B-43666, except for the cap which is similar to the cap used for the HSC box discussed above. Unless otherwise specified, prior to loading, the Style HSCS box shall be placed on a pallet or wood skid which shall be one inch longer and one inch wider than the box. See paragraph 7-11c(2) and figure 7-11, Type III Style 4, for details of half slotted body and the flanged tube (telescoping sleeve). See figure 2-8, HSC style box, for the details of the cover.

(f) *DCC, double cover.* Construction features of this box are similar to the DBLCC style box of Specification PPP-B-636. See paragraph 2-1j(12) and figure 2-8 for details.

(2) *Classes, types, and grades.* The available classes, types, and grades are shown in table 2-10.

c. *Size Limitations.* For commodities covered therein, Rule 41 of the Uniform Freight Classification limits the sum of the inside length, width, and depth dimensions to 120 inches. For commodities not covered by Rule 41, there are no size limitations on the boxes.

Table 2-10. Classes, Types, and Grades of Wax-Resin Impregnated Fiberboard Boxes (PPP-B-1163)

Class I—High Compression Strength ¹		Class II—Low Water Absorbing ²	
Type SWCFI ³	Type DWCFI ⁴	Type SWCFI ³	Type DWCFI ⁴
Grade 125	Grade 275	Grade 250	Grade 350
Grade 175	Grade 350	Grade 275	Grade 450
Grade 200	Grade 450	Grade 300	Grade 600
Grade 250	Grade 600	Grade 350	
Grade 275			
Grade 300			
Grade 350			

¹ Primarily intended for shipping containers.² Primarily intended for pallet shrouds and sheathing.³ Single-wall corrugated fiberboard, impregnated.⁴ Double-wall corrugated fiberboard, impregnated.**d. Closure Requirements.**

(1) *Styles RSC, OSC, and TC.* The requirements for the closure of these styles are the same as the requirements for the corresponding styles as specified in the appendix of Specification PPP-B-636, with the exception that the use of Specification MIL-T-43115 tape is authorized in addition to the use of Specification PPP-T-60 tape. See paragraphs 2-1n(2) and (3), above, for details.

(2) *Style HSC.* The closure requirements for this style are the same as for the corresponding style as specified in the appendix of Specification PPP-B-636. See paragraph 2-1n(6) for details.

(3) *Style HSCS.* The closure of this style shall be accomplished by the use of steel straps conforming to Type I, Class A or B, of Specification QQ-S-781, or nonmetallic strapping conforming to Type I, Grade B, and Type II, and Type III of Specification PPP-S-760. Two straps, positioned approximately 10 inches from the edge of the box,

shall be placed lengthwise around the box. These straps shall be placed either on top or beneath the pallet or skid. Straps also shall be placed girthwise around the box, within six inches of each end, plus one additional strap for every 24 inches of box length. These straps shall be placed under or through the pallet or skid in such a manner as not to be changed during the handling and shipping.

2-4. Paperboard Boxes

Paperboard boxes are mainly used for interior packing. They are available in various types, styles, and sizes, and must conform to the requirements of Specification PPP-B-566, and PPP-B-676. In many instances, depending upon the item, a paperboard box may be used in packing when utilizing parcel post (para 1-27). For further details on paperboard boxes, see volume I of this manual.

CHAPTER 3

WOODEN CONTAINERS AND PALLETS

3-1. Container Materials

a. Wood as a Container Material. Wood is particularly valuable as a container material because of its high strength-weight ratio which compares favorably with mild steel. Tests and experience have shown that the strength of a wooden container depends largely upon the type of wood used in its construction. The durability of wood and its ability to withstand shock and impact stresses are important properties in the selection of wood for containers. The quality of wood members for containers and pallets is set forth in Military Standard MIL-STD-731, "Quality of Wood Members for Containers and Pallets." Military Handbook MIL-HDBK-7, "Lumber and Allied Products," provides a ready source of information on wood products normally procured in considerable quantity for Department of Defense installations. This handbook is not intended for reference in purchase specifications or other contractual documents. However, it will assist materially with installation requisitioning, receiving, inspection, storage, and handling of container wood materials.

(1) *Wood groups.* All woods fall into two general categories: either softwoods, which come from coniferous or needle-bearing trees; or hardwoods, which come from broad-leaved trees. For purposes of container construction, wood is divided into four groups based on nail holding power, tendency to split, comparative strength as a beam, and shock resisting capacity (fig 3-1). Over 90 percent of all wooden containers are made from Group I and II woods. However, the materials given in Section 3 of the applicable container specification must be used. When a wood group is specified in the contract, any species in that group may be selected.

(a) Group I includes the softer woods such as white fir, ponderosa pine, yellow poplar, cottonwood, cedar, and others. These woods are relatively free from splitting when being nailed, have moderate nail-holding power, moderate strength as a beam, and moderate shock resisting capacity.

(b) Group II includes the harder soft woods such as Douglas fir, southern pine, hemlock, and

larch. They have greater nail-holding power than the Group I woods, as well as greater strength and shock resisting capacity. Group II woods are more inclined to split, the grain often deflects nails and causes them to run out at the side of the piece.

(c) Group III includes the medium density hardwoods. Ash, elm, and cherry are examples. These are similar to Group II woods in nail-holding power and strength as a beam, but have less tendency to split and shatter under impact.

(d) Group IV includes the true hardwoods such as oak, hard maple, and hickory. These woods have the greatest shock resistance and nail-holding power, are extremely strong, but are very susceptible to splitting. They are the heaviest and hardest domestic woods, and are difficult to work.

(2) *Wood defects.* All boards should be cut to the correct length and be free from all defects that materially weaken them, expose the contents of the box to damage, or interfere with the prescribed fabrication or nailing (fig 3-2).

(a) *Knots.* Knots in wood are most weakening when located in the middle third of the length of the board. Across the width of the board, the weakening effect is proportional to the effective diameter (measured as shown in fig 3-3) of the knots. No knot, or series of knots across the face of the board, within a length equal to the width of the board, shall have a diameter or sum of diameters greater than one third the width of the board. No knot will exceed 4 inches when measured across the width of the board.

(b) *Slope of grain.* Any board with a slope of grain steeper than a ratio of 1 in 10 of length is not permissible. Figure 3-2 shows the results of excessive slope or cross grain.

(3) *Moisture content.* It is important that the moisture content of lumber required by an applicable container specification be followed. High moisture content in lumber will cause excessive tare weight. Shrinkage, due to the loss of high moisture content in the boards of a nailed wood box will cause gaps between the pieces of lumber.

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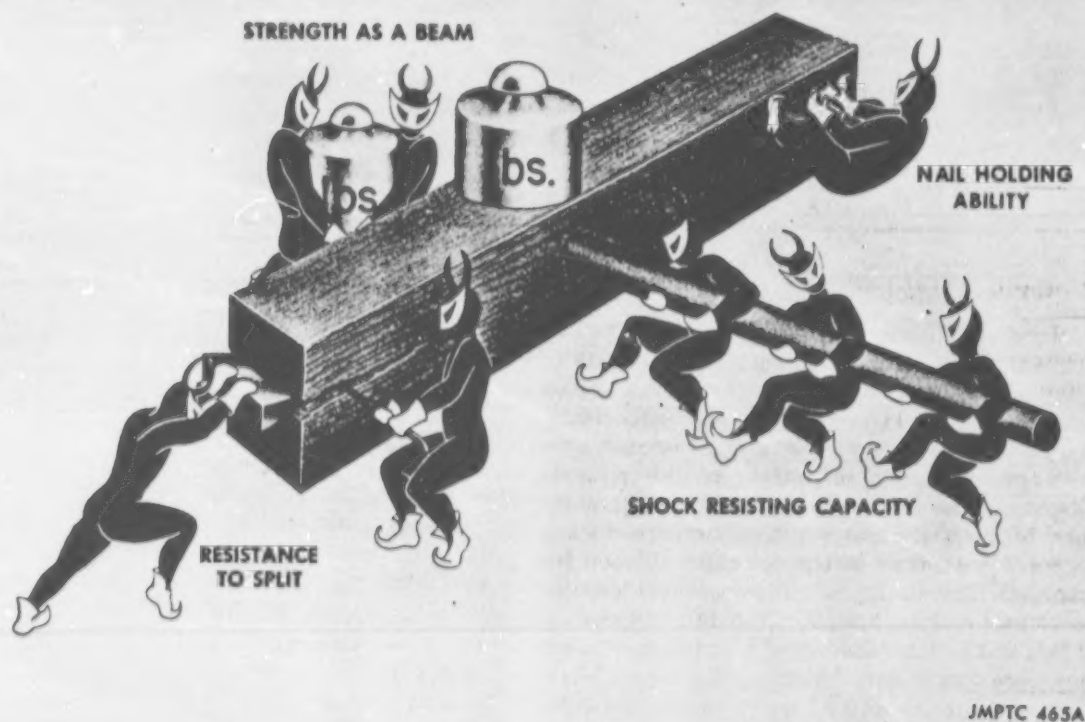


Figure 3-1. Characteristics for the classification of wood.

Shrinkage will also cause the loss of nail holding-power, splitting of the lumber at the nails, and the loosening of straps. Moisture content is determined by the use of electric moisture meters or by the oven dry method, as outlined in Military Standards MIL-STD-1363 and MIL-STD-731.

(a) *Moisture meter method.* The moisture meter method is faster than the oven dry method, but less accurate. A moisture meter consists essentially of an electrical device designed to measure the resistance or the capacitance of the wood between two electrodes in contact with the sample. The values obtained will vary with the water content of the wood. They will also vary as a result of a number of other factors, most important of which are the temperature of the wood, its species, and density. Although correction tables are furnished with each instrument which must be used for even approximations of true values, the readings obtained are still only approximations because the effect of the other variables cannot be determined with scientific accuracy. Instruments of this type cannot be used where an accuracy of plus or minus 1 percent is required. In view of the foregoing, the moisture meter method is primarily usable for screening inspections of large lots of lumber, while the oven dry method is

almost always resorted to in the event of disputes. The meter used should be capable of giving instantaneous readings of moisture content within a range of 7 to 20 percent, and should be equipped with correction tables to permit the correction of meter readings for temperature, species, and density. The meter should be adjusted prior to use in accordance with the manufacturer's instructions. When a series of readings are being made, the adjustment should be checked periodically. Batteries should be replaced whenever initial adjustment cannot be accomplished, or whenever it is obvious that inaccurate readings are being obtained because of weak batteries. The following general precautions should be observed:

1. The entire area of plate-type electrodes should be in contact with the wood. Do not use this type of electrode on rough wood.
2. Drive the needle-type electrodes to their full depth and in such a manner that the flow of current will be parallel to the wood grain. When wood splitting occurs, discard the reading obtained. Where the wood is over one inch thick, drive $1\frac{1}{4}$ to $1\frac{1}{2}$ -inch nails, spaced the same distance apart as the electrodes, straight into the wood to a depth equal to approximately one-fifth the thickness of the piece. These nails must not be

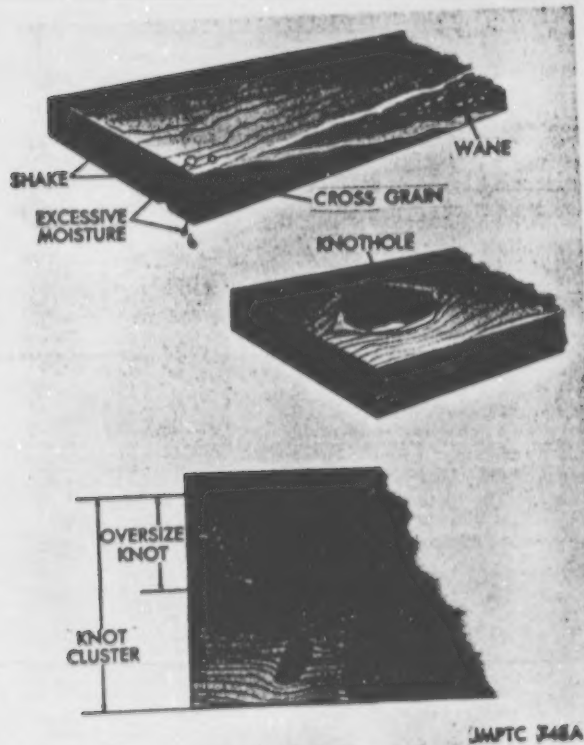


Figure 3-8. Wood defects.

cement coated but may be either bright or chemically etched.

3. Never use the meter on wood whose surface is wet with rain, dew, or fog.

4. Never use the meter on the ends of a piece.

5. Never use the meter on a painted or otherwise finished piece.

6. Never use the meter on composite pieces where the current between the two electrodes will have to pass through a glue joint.

7. Do not use the meter on a piece just removed from the kiln since the temperature correction tables (which are concerned with the temperature of the piece) will not be applicable.

8. On thin pieces, do not support the piece on another piece of lumber, metal, or other material which may give false electrical readings.

(b) *Oven dry method.* Use a drying oven capable of maintaining a constant temperature of 212° F. to 221° F., and a scale that is accurate to within one-half of 1 percent. To determine the moisture content, use the following procedure:

1. Cut off at least the first 12 inches of the piece in order to avoid the effects of end drying.

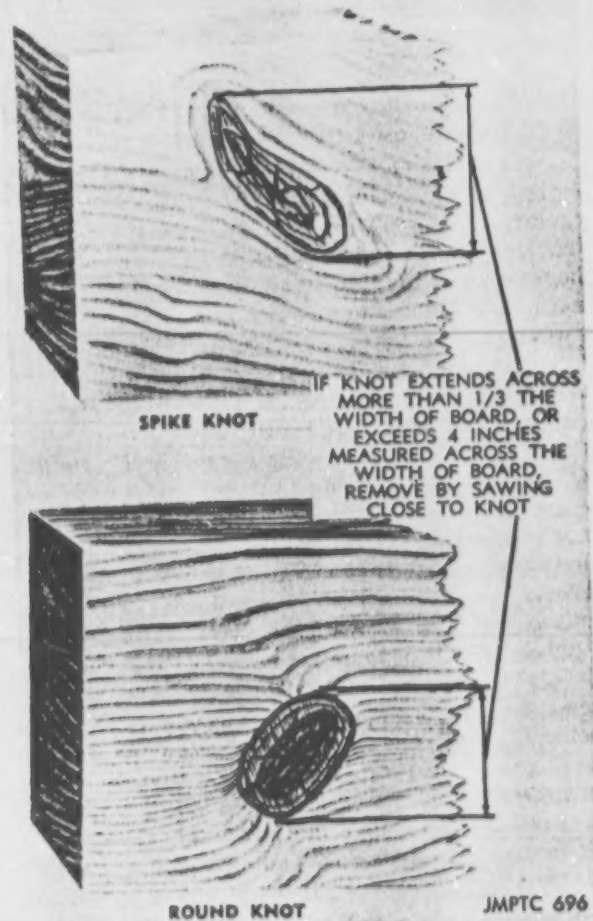


Figure 3-9. Measuring knot diameters.

2. As soon as possible, cut off a piece approximately 1 inch the full thickness by the full width of the piece.

3. Immediately after sawing, remove all loose splinters and determine W, the weight before drying.

4. Place the wood in the hot oven and leave overnight. The next day, weigh the specimen and replace in the oven. Repeat at 2-hour intervals until the weight is the same at the end of two successive 2-hour periods. This will occur after approximately 24 hours. If more than one, specimens must be open-piled in the oven to allow free access of air to all parts of the pieces.

5. The final weight of the piece immediately after removal from the oven is D, the oven dry weight.

6. Calculate the percentage of moisture content by using the following formula:

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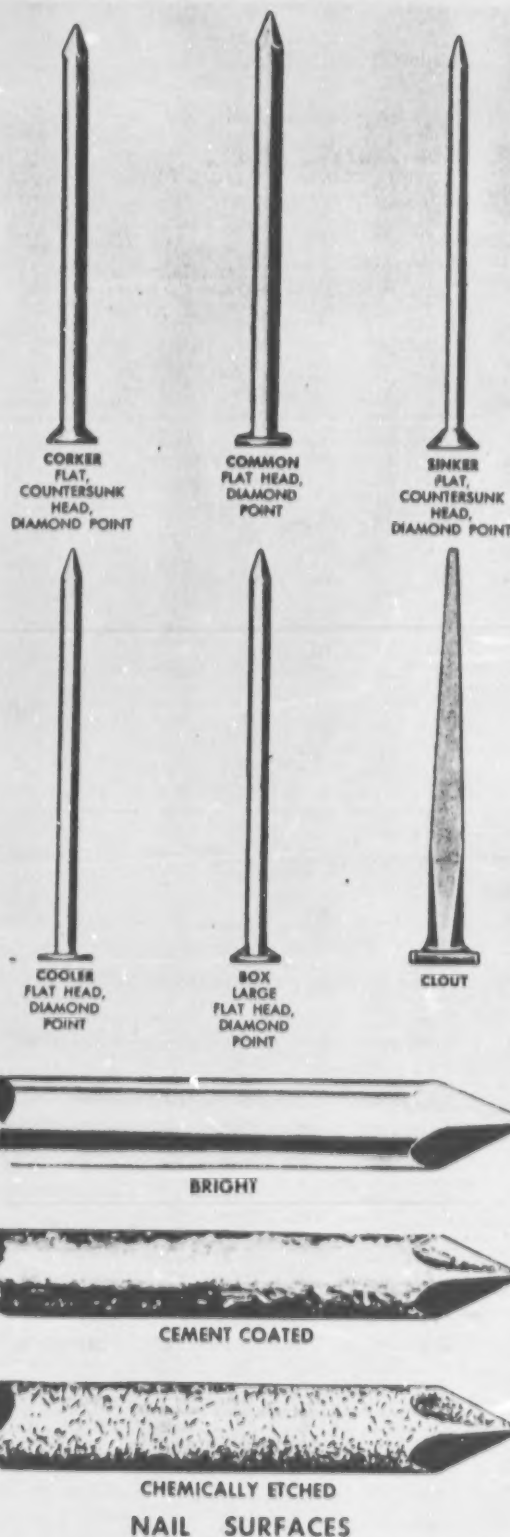
$$\frac{(W-D) \times 100}{D} = \% \text{ Moisture}$$

b. *Other Materials Used in Container Construction.* The following additional materials are used in container construction as applicable:

(1) *Nails (FF-N-105).* These may be box, corker, sinker, cooler, or common nails. Sinker and cooler nails are relatively slender, can be driven into denser woods and withstand shocks well. The heads do not break off or pull through the wood easily (fig 3-4). The resistance of nails to withdrawal varies with a number of factors such as the hardness or density of the wood, surface condition of the nails, and the shape and form of the nails. Dense woods hold nails much better than soft woods. To get the same nail strength with softer woods, more nails or larger nails are required. The use of chemically etched or coated nails is particularly important with soft woods. Resistance of nails to withdrawal also varies with the area of contact of the nail with the wood, increasing directly with the diameter of the nail and the depth of penetration. Nails may be subjected to forces which withdraw them directly, that is, in the direction of their length, or to forces which displace them laterally. Nails offer greater resistance to lateral displacement than to direct withdrawal. Cement coating or etching increases the resistance of nails in direct withdrawal more than in lateral withdrawal, since the nail shank is distorted in lateral withdrawal about the same, whether coated or uncoated. Etched nail surfaces have certain advantages over cement coated surfaces. The effect of etching in increasing withdrawal resistance is relatively permanent, while cement coatings deteriorate a few months after nailing. Etched nails are effected with woods of all densities, while cement coatings tend to rub off when nails are driven into dense woods. Here is a simple procedure for etching nails. Prepare a 10 percent solution (by weight) of commercial monoammonium phosphate in water. Do not use metal container for preparing or storing the solution. Keep the solution near room temperature (about 68° F). Immerse the nails in the solution for about 7 hours, stirring occasionally. Five gallons of solution is sufficient to etch about 100 pounds of nails. At the end of the etching period, remove the nails and rinse with water. Finally, air-dry the nails to prevent rusting.

(2) *Screws (FF-S-111).* Sometimes it is particularly desirable to use screws for closing wooden boxes when the contents are such that they need to be checked, lubricated, or inspected.

(3) *Corrugated fasteners (FF-F-133).* Corru-



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Figure 3-4. Types of nails.

gated fasteners are used in the construction of built-up faceboards in wooden boxes (figure 3-11). When used for this purpose, nailing machine operators do not have to align each board prior to nailing. Corrugated fasteners also help to prevent pilferage of contents during storage or shipment.

(4) *Staple (FF-N-1053)*. Staples are used to attach cleats to panels on cleated panel boxes. Staples, crowns not less than one-half inch, must be long enough to penetrate the thickness of panel material and cleat with a minimum clinch of one-eighth inch.

(5) *Wire fasteners*. Fasteners, other than nails, and staples, may be used to attach cleats to plywood or veneer panels. They must provide lateral displacement equal to that of nails properly spaced and driven. Wire fasteners are formed and driven by machine from a roll of knurled wire.

(6) *Strapping*. Either flat metal or round wire conforming to Specifications QQ-S-781 are used to strap wooden containers.

(7) *Plywood (NN-P-530)*. Plywood used for boxes, either for domestic or oversea destinations, shall be as specified in the procurement document or other directive establishing the container requirements. Plywood will be purchased in accordance with Federal Specification NN-P-530.

(8) *Fiberboard (PPP-F-320)*. For oversea cleated panel boxes, solid V-board with a minimum dry bursting strength of 400 pounds is the only material authorized. For domestic cleated panel boxes, either solid fiberboard, solid pulpboard, or doublefaced corrugated board may be used (para 2-1h).

(9) *Paper overlaid veneer (PPP-V-205)*. This material, made of thin veneer covered on both faces with heavy kraft paper, is used as panelling material for paper overlaid veneer boxes, conforming to Specification PPP-B-576.

3-2. Nailed and Lock-Corner Wood Boxes (PPP-B-621)

a. *Description and Selection*. The nailed wood box is constructed of wood, assembled by fastening the top, sides, and bottom to the ends with nails, or by gluing the lock-corners of the sides and ends and fastening them to the top and bottom with nails. The placement of cleats on the ends or the lack of cleats determines the style of box. Nailed wood boxes will not be used if fiberboard or less expensive light-weight boxes will provide adequate protection for shipment and storage.

b. *Characteristics*. Nailed wood boxes are satis-

factory shipping containers for supplies and equipment, especially for items that are susceptible to damage. These containers have the following favorable and unfavorable characteristics:

(1) *Favorable characteristics*.

(a) Maximum protection to contents against damage due to puncture, distortion, and breakage.

(b) Ability to support loads due to stacking during transit and storage.

(c) Ability to contain difficult loads without undue distortion.

(d) Adaptability to complex wood blocking and bracing.

(e) Adaptability to varying strengths by adjusting the style of box, thickness of materials, and group of wood.

(f) Easy workability and simple construction.

(2) *Unfavorable characteristics*.

(a) High tare weight and cube.

(b) Not watertight.

(c) Tendency to wrack.

c. *Classes and Grades (fig 3-5)*. The classes of nailed wood boxes are—

(1) *Class 1, domestic boxes*. These boxes are subject to storage, rehandling, or shipment to domestic destinations in which no sea transportation is involved. Net weight is limited to a maximum of 600 pounds.

(2) *Class 2, oversea boxes*. These boxes are subject to storage, rehandling, or reshipment to offshore and oversea destinations. Net weight is limited to a maximum of 1,000 pounds. Class 2 boxes (all styles) shall be furnished in the following grades, as specified. When no grade is specified in the contract, purchase order, or other procurement document, Grade B shall be supplied.

(a) Grade A—With preservative treatment.

(b) Grade B—Without preservative treatment.

d. *Styles and Limitations*. Class 1 and 2 boxes are described simultaneously, as applicable, in the coverage of the box styles 1, 2, 2½, 3, 4, 4½, 5, 6, and 7 are permitted for Class 1 (domestic) and Styles 2, 2½, 3, 4, 4½, 5, 7, and shallow boxes are permitted for Class 2 (overseas) shipments. Weight limitations for each class, as applicable, are given under the description of each style of box.

(1) *Style 1 box (fig 3-6)*.

(a) Style 1 box is identified by lack of cleats on the end faceboards and single line nailing of

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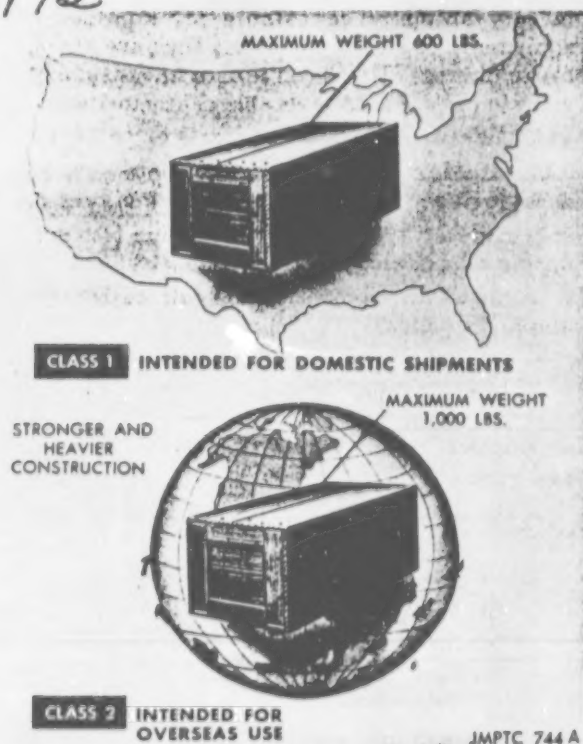


Figure 3-5. Classes of nailed wood boxes.

sides to ends, and of top and bottom to ends and sides.

(b) Style 1 box is intended for domestic shipments only. It is restricted to Type 1 and 2 loads.

(c) Style 1 box may not exceed a load limit of 50 pounds for two-piece sides and 100 pounds for one-piece sides.

(d) Direction of the grain on Style 1 box must run in the direction of the greatest dimension.

(e) This box is limited to a height of 10 inches and total dimensions (length, width, and depth) of 50 inches.

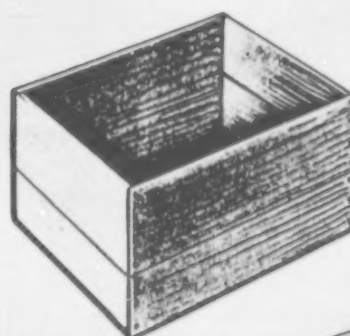
(2) Style 2 box (fig 3-6).

(a) Style 2 box is identified by two vertical and two horizontal cleats on each end.

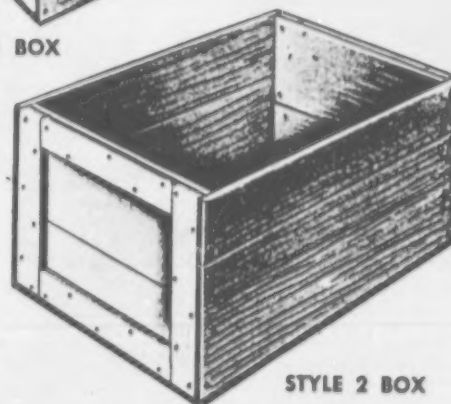
(b) Vertical cleats are positioned at right angles to the grain of the end. They are one-eighth of an inch shorter than the edge of the end at the top and bottom.

(c) Horizontal cleats, which are placed parallel to the grain of the end, are butt-jointed to the vertical cleats and are flush with the top and bottom edges of the box.

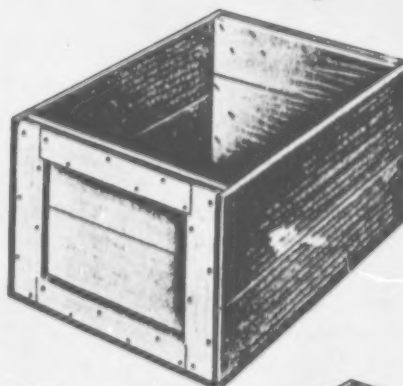
(d) The top, bottom, and sides extend over the ends and cleats and are nailed in a staggered



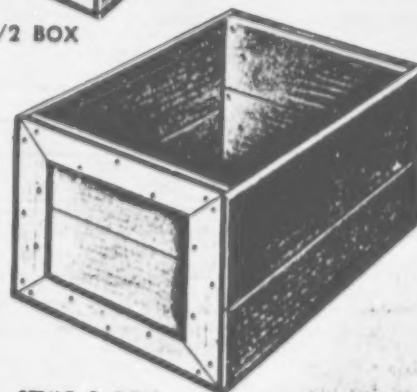
STYLE 1 BOX



STYLE 2 BOX



STYLE 2-1/2 BOX



STYLE 3 BOX

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Figure 3-6. Styles of nailed wood boxes (1).

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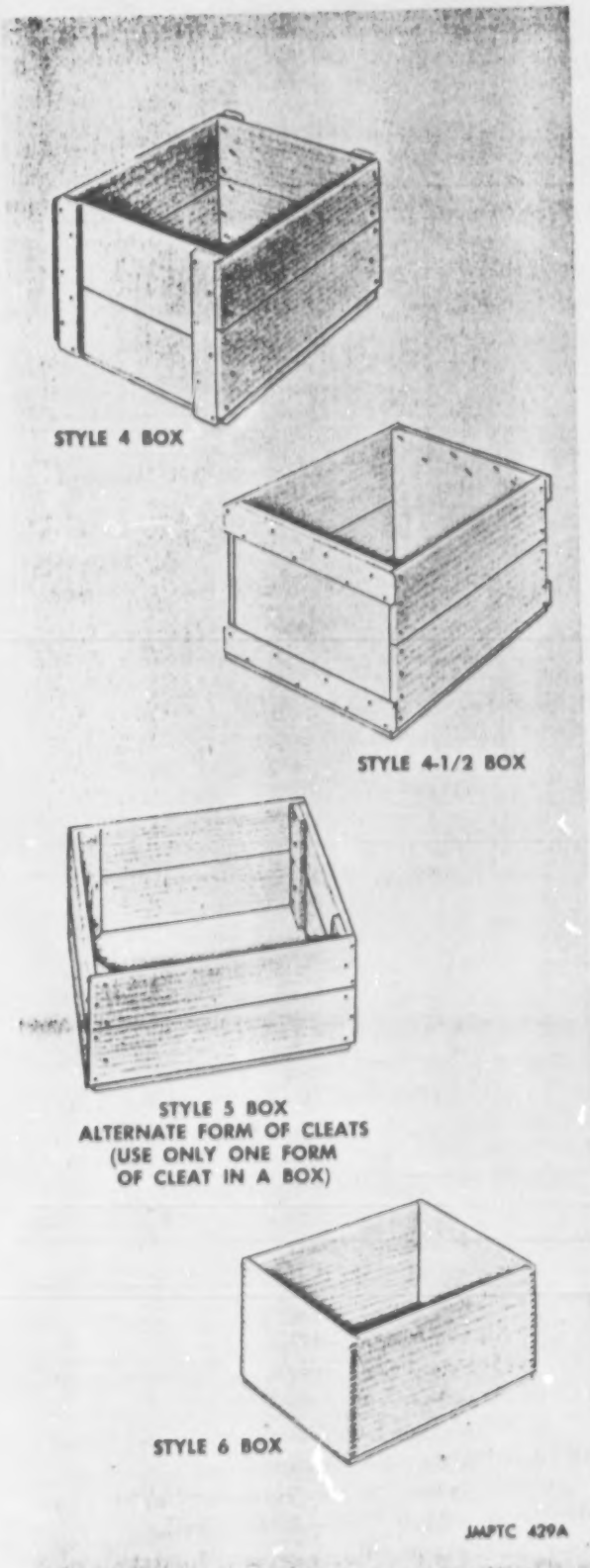


Figure 3-7. Styles of nailed wood boxes (2).

pattern. Thus, there is some side-grain nailing on all edges.

(e) The cleat pattern provides ease of handling.

(f) Weight limitation for a Style 2, Class 1 box (domestic) is 600 pounds.

(g) Weight limitation for a Style 2, Class 2 (overseas) box is 1,000 pounds.

(3) *Style 2 1/2 box (fig 3-6).*

(a) Style 2 1/2 box is identified by two vertical notched cleats and two horizontal cleats on each end.

(b) It has the same advantages as the Style 2 box, but is slightly higher in cost.

(c) Vertical cleats are notched approximately one-fourth to three-eighths inch to support the horizontal cleats. Vertical cleats are positioned one-eighth inch above the bottom edge of the end.

(d) Weight limitation for Style 2 1/2, Class 1 box (domestic) is 600 pounds.

(e) Weight limitation for Style 2 1/2, Class 2 box (overseas) is 1,000 pounds.

(4) *Style 3 box (fig 3-6).*

(a) Style 3 box is identified by four 45° mitered cleats on each end.

(b) It has the same advantages as Style 2 and 2 1/2 boxes, but is more expensive to fabricate.

(c) Weight limitation for Style 3, Class 1 box (domestic) is 600 pounds.

(d) Weight limitation for Style 3, Class 2 box (overseas) is 1,000 pounds.

(5) *Style 4 box (fig 3-7).*

(a) Style 4 box is identified by two vertical cleats on each end.

(b) Vertical cleats, which are positioned at right angles to the grain of the end, are one-eighth inch shorter than the outside surfaces of the top and bottom of the box.

(c) The top and bottom cover the sides. They fit between the cleats and are attached to the ends by straightline, side-grain nailing. The sides overlap the ends and cleats, providing for a staggered nailing pattern.

(d) Weight limitation for Style 4, Class 1 box (domestic) is 250 pounds.

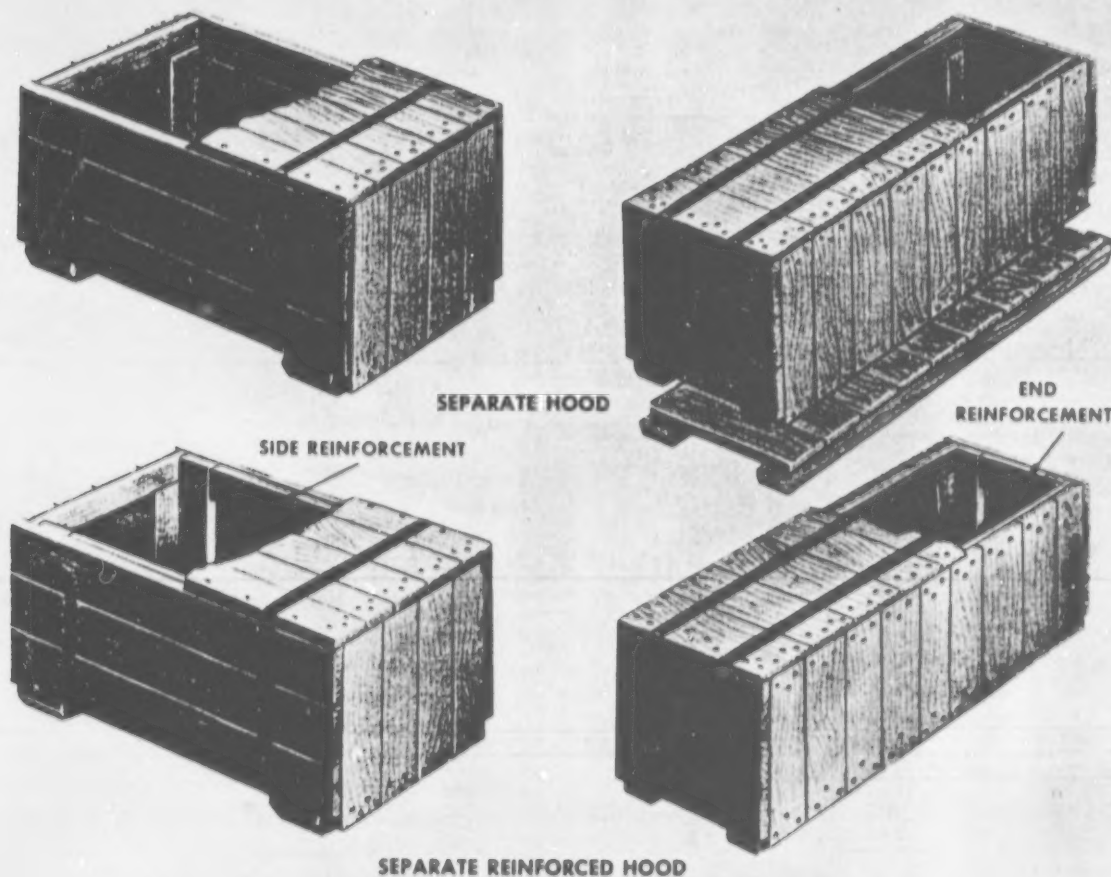
(e) Weight limitation for Style 4, Class 2 box (overseas) is 400 pounds.

(6) *Style 4 1/2 box (fig 3-7).*

(a) Style 4 1/2 box is identified by two horizontal end cleats.

(b) Horizontal cleats, which are positioned

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Figure 3-8. Style 7 nailed wood box.

at right angles to the grain of the end, are one-eighth inch shorter than the outside surface of the sides.

(c) The sides extend over the ends, and provide for straight-line, side-grain nailing. The top and bottom extend over the ends and cleats, and provide for both side- and end-grain nailing.

(d) Weight limitations for both classes of boxes are the same as for Style 4 boxes.

(7) *Style 5 box (fig 3-7).*

(a) Style 5 box is identified by interior vertical cleats.

(b) The cleats extend to within one-eighth inch from the top and bottom edges of the end of the box.

(c) Other than the placement of cleats, construction and nailing pattern for this container is the same as for Style 4 box.

(d) The interior cleats may be rectangular or triangular, provided the cross section area of the triangular cleat is not less than that of the required rectangular cleat.

(e) Weight limitation for Style 5, Class 1 box (domestic) is 250 pounds.

(f) Weight limitation for Style 5, Class 2 box (overseas) is 400 pounds.

(8) *Style 6 box (fig 3-7).*

(a) Style 6 box is identified by the lockcorner construction which is glued.

(b) This box has about the same advantages and disadvantages as Style 1 box.

(c) Style 6 box is intended for domestic shipments only and Type 1 and 2 loads.

(d) This box has a weight limitation of 50 pounds, but may go to 100 pounds if the box has one-piece sides.

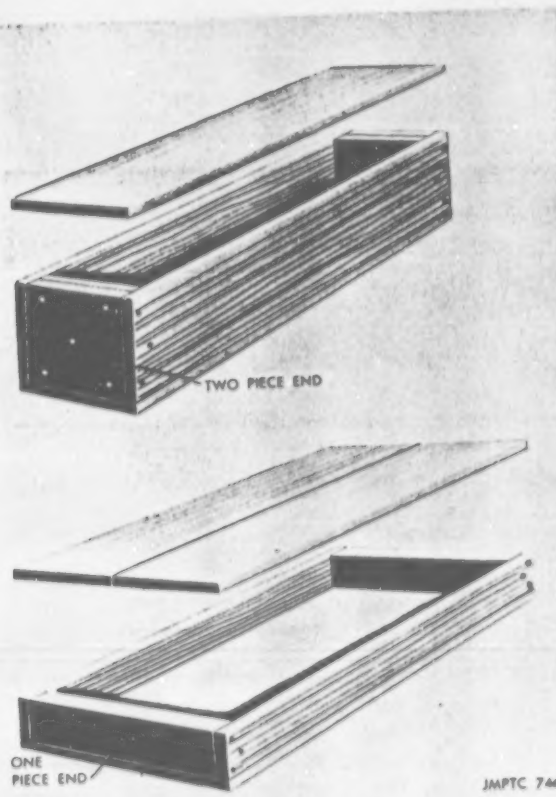


Figure 3-9. Shallow boxes.

(9) Style 7 box (fig 3-8).

(a) Style 7 box is an internally reinforced box consisting of a skidded base with a separate hood assembled from the top, sides and ends.

(b) Style 7 boxes are for contents ranging from 100 to 1,000 pounds. The contents must readily permit attachment to the skids.

(c) The base is assembled to 2 x 4 inch skids to facilitate mounting to a skid base.

(d) The skids are positioned across the extreme ends of the bottom pieces to permit attachment of all end pieces to the skid edges.

(e) Vertical and horizontal framing members and reinforcing members in the form of a rectangle, and cross diagonals, as applicable, are attached to the interior surfaces of the prefabricated box panels. Framing members are required when contents exceeds 250 pounds or when side length is greater than end length.

(f) End panels are identified by vertical sheathing which extends within one-eighth of an inch of each skid bottom.

(g) The hood assembly is placed over the

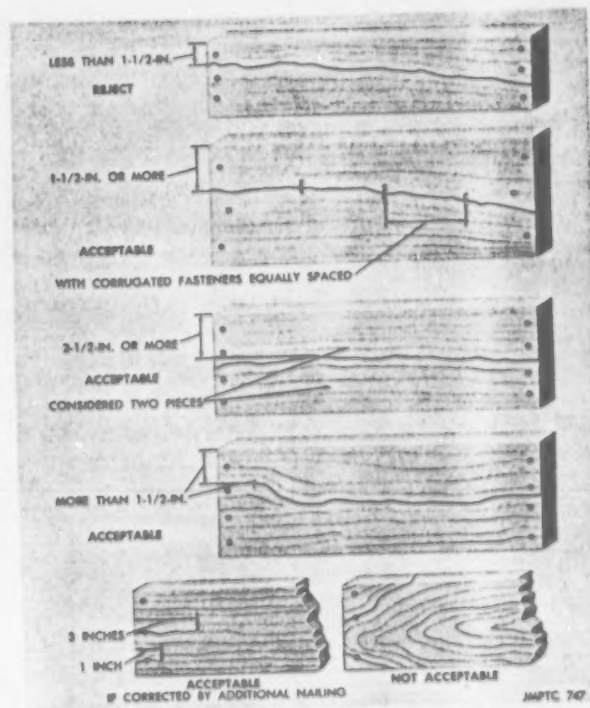


Figure 3-10. Split board rules.

item mounted to the base, then nailing and strapping is accomplished.

(h) Style 7 boxes are intended for both Class 1 and Class 2 use.

(10) Shallow box (fig 3-9).

(a) When the inside depth of a box is five inches or less, cleats are not used. If cleats were applied to shallow boxes, they would be so small that in attaching them to the ends they would split.

(b) The end of the box may be made of one piece, or if the end is approximately square, it may be made of two pieces placed so that the grain runs in opposite directions.

(c) For Style 2, 2 1/2, 3, 4, and 4 1/2 boxes, the thickness of the ends shall be not less than the combined thickness of the end and cleat, as specified.

(d) Slides overlap the ends.

(e) Top and bottom overlap the sides and ends.

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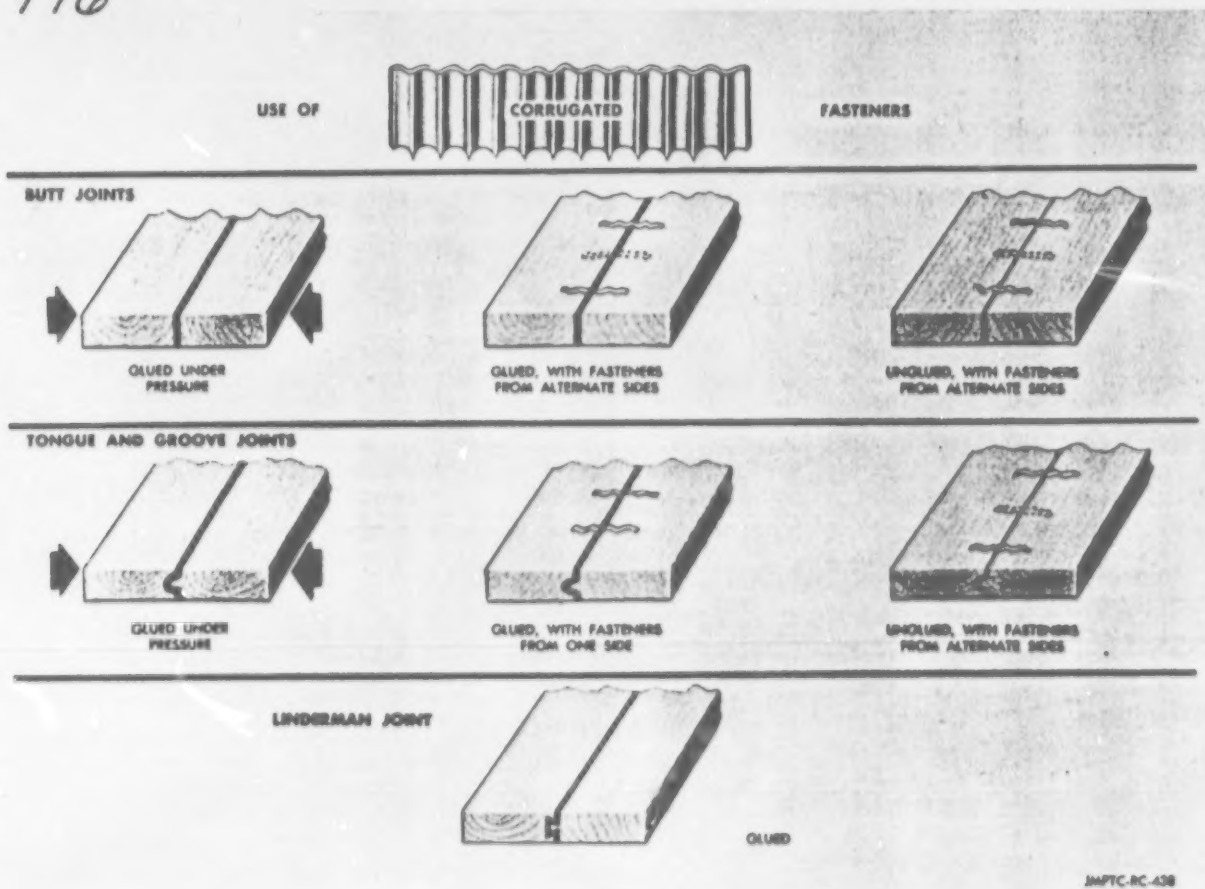


Figure 3-11. Jointed pieces of lumber.

(f) Top, bottom, and sides are attached to the ends by staggered nailing.

(g) Weight limitation is 1,000 pounds for oversea shipments.

e. *Construction Details.* When nailed wood boxes are built locally, use the following information for constructing and closing the various styles. If purchased and received in shook form, the sides, top, and bottom will be ready to be attached to the constructed ends. Figure 3-10 shows the amount of acceptable splitting allowed in the component parts.

(1) *Size of lumber.* The size of lumber used in nail wood box construction is found in tables 3-1, 3-2, 3-3, and 3-4. Information necessary to use these tables is: Class of box, type of load, net weight, style of box, and group of wood.

(2) *Construction of built-up faceboard pieces* (fig 3-11). The number of pieces in any side, top, bottom, or end will be chosen so that no single

solid piece or built-up piece shall be less than $2\frac{1}{2}$ inches in width measured across the face, and will not exceed the number given in table 3-5. Built-up face-board pieces may be constructed according to the following conditions:

- (a) The Linderman joint when glued.
- (b) Butt joints glued under pressure.
- (c) Tongued and grooved joints glued under pressure.
- (d) Tongued and grooved joints glued with two or more corrugated fasteners driven from one side.
- (e) Tongued and grooved unglued joints with two or more corrugated fasteners driven from alternate sides.

(3) *Additional cleats and battens.* Additional cleats will be made of the same size lumber as the regular cleats. They are placed on the ends of a box when required, according to length of unsupported span (table 3-6). Additional cleats applied

Table 3-1. Boxes for Domestic Shipment, Type 1 (Easy) and Type 2 (Average) Loads; Thickness of Sides, Tops, Bottoms, and Ends; and Thickness and Width of Cleats

Weight of contents		Style of box ^a	Groups I and II woods			Groups III and IV woods		
Exceeding	Not exceeding		Thickness of sides, tops and bottoms ¹	Thickness of ends ¹	Thickness ¹ and width ² of cleats	Thickness of sides, tops and bottoms ¹	Thickness of ends ¹	Thickness ¹ and width ² of cleats
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
	50	1	3/8	1/2		1/4	1/2	
	50	4, 4-1/2, 5	3/8	1/2	1/2 x 1-3/4	1/4	1/2	1/2 x 1-3/4
	50	2	3/8	3/8	3/8 x 1-1/2	1/4	3/8	3/8 x 1-1/2
	50	6	1/4	1/2		3/16	3/8	
50	100	1 ³	3/8	3/4		3/8	5/8	
50	100	4, 4-1/2, 5	3/8	5/8	5/8 x 2-1/4	3/8	5/8	5/8 x 1-3/4
50	100	2, 2-1/2, 3	3/8	1/2	1/2 x 1-3/4	3/8	1/2	1/2 x 1-3/4
50	100	6 ³	3/8	3/4		3/8	5/8	
100	250	4, 4-1/2, 5	1/2	5/8	5/8 x 2-1/4	1/2	5/8	5/8 x 2-1/4
100	250	2, 2-1/2, 3, 7	1/2	5/8	5/8 x 1-7/8	1/2	5/8	5/8 x 1-3/4
250	400 ⁴	2, 2-1/2, 3, 7	5/8	3/4	3/4 x 2-5/8	1/2	5/8	5/8 x 2-1/4

¹ Thickness tolerance is plus or minus 1/16 inch for parts 3/8 inch thick and thicker. Thickness tolerance is plus 1/16 inch, minus 1/32 inch for pieces less than 2/4 inch thick.

² Width tolerance is plus or minus 1/16 inch.

³ Style 1 and style 6 boxes may be used to carry a net weight exceeding 50 pounds but not exceeding 100 pounds if the boxes have one-piece solid sides of sawed lumber and contents are packed in interior containers.

⁴ When load to be carried by the box exceeds 400 pounds, use table 3-3; exceeds 600 pounds, use table 3-4.

⁵ Style 2, 2-1/2, 4, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall not be less than the combined thickness of the end and cleat as specified.

Each side and end shall be made from one piece except when the end is approximately square, a two-piece end with each end piece of approximately equal thickness and with the grain of each piece running at right angles to the other may be used.

Two-piece end shall be nailed together with no less than 2 nails clinched.

Table 3-2. Boxes for Domestic Shipment, Type 3 (Difficult) Loads; Thickness of Sides, Tops, Bottoms, and Ends; and Thickness and Width of Cleats

Weight of contents		Style of box ^a	Groups I and II woods			Groups III and IV woods		
Exceeding	Not exceeding		Thickness of sides, tops and bottoms ¹	Thickness of ends ¹	Thickness ¹ and width ² of cleats	Thickness of sides, tops and bottoms ¹	Thickness of ends ¹	Thickness ¹ and width ² of cleats
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
	50	4, 4-1/2, 5	3/8	5/8	5/8 x 1-3/4	3/8	5/8	5/8 x 1-3/4
	100	4, 4-1/4, 5	1/2	3/4	3/4 x 2-1/4	1/2	5/8	5/8 x 1-3/4
50	100	2, 2-1/2	1/2	5/8	5/8 x 1-3/4	1/2	5/8	5/8 x 1-3/4
100	250	4, 4-1/2, 5	5/8	3/4	3/4 x 2-1/4	1/2	3/4	3/4 x 2-3/8
100	250	2, 2-1/2, 3, 7	5/8	3/4	3/4 x 2-1/4	1/2	5/8	5/8 x 2-1/4
250	400	2, 2-1/2, 3, 7	3/4	3/4	1-1/16 x 3-1/4	5/8	3/4	3/4 x 2-1/4
400	600 ³	2, 2-1/2, 3, 7	3/4	13/16	1-1/16 x 3-1/4	3/4	3/4	3/4 x 2-3/4

¹ Thickness tolerance is plus or minus 1/16 inch for parts 3/8 inch thick and thicker. Thickness tolerance is plus 1/16 inch, minus 1/32 inch for pieces less than 5/8 inch thick.

² Width tolerance is plus or minus 1/16 inch.

³ When load to be carried by the box exceeds 600 pounds, use table 3-4.

⁴ Style 2, 2-1/2, 3, 4, 4-1/2 boxes. Unless otherwise specified when the inside depth of the box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat as specified. Each side and end shall be made from one piece except when the end is approximately square, a two-piece end with each end piece of approximately equal thickness and with the grain of each piece running at right angles to the other may be used. Two-piece ends shall be nailed together with no less than two nails clinched.

to ends run across the grain of the end (right angle to grain direction) and midway between the regular cleats. Battens are made of the same size lumber as regular cleats. Battens are used on the sides, top, and bottom when the limit of unsupported span is exceeded (table 3-6). Wherever possible, and without increasing the size of the container, battens should be placed inside the box. When battens are required to be placed on the outside of a box without skids, not less than two

sets shall be attached across the sides, top, and bottom. They shall be applied so that those on the top and bottom extend over the ends of the side battens. They shall be located not less than 2 1/2 inches nor more than one sixth the length of the box with respect to each box end. However, that distance and the interval between sets of battens shall be not more than maximum span specified in table 3-6. Exterior battens shall be applied to boxes with skids in the same manner as required

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Table 3-3. Boxes for Oversea Shipment, Type 1 (Easy) and Type 2 (Average) Loads; Thickness of Sides, Tops, Bottoms, and Ends; and Thickness and Width of Cleats

Weight of contents		Style of box ¹	Groups I and II woods			Groups III and IV woods		
Exceeding	Not exceeding		Thickness of sides, tops and bottoms ²	Thickness of ends ²	Thickness ² and width ² of cleats	Thickness of sides, tops and bottoms ²	Thickness of ends ²	Thickness ² and width ² of cleats
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
0 -----	50 -----	4, 4-1/2, 5 -----	3/8	5/8	5/8 x 1-3/4	3/8	5/8	5/8 x 1-3/4
50 -----	100 -----	4, 4-1/2, 5, 7 -----	1/2	3/4	3/4 x 2-1/4	3/8	5/8	5/8 x 1-3/4
100 -----	250 -----	4, 4-1/2, 5 -----	5/8	3/4	3/4 x 2-1/4	1/2	3/4	3/4 x 2-1/4
100 -----	250 -----	2, 2-1/2, 3, 7 -----	5/8	5/8	5/8 x 2-1/4	1/2	5/8	5/8 x 2-1/4
250 -----	400 -----	4, 4-1/2, 5 -----	3/4	3/4	3/4 x 2-5/8	5/8	3/4	3/4 x 2-1/4
250 -----	400 -----	2, 2-1/2, 3, 7 -----	3/4	13/16	3/4 x 2-5/8	5/8	3/4	3/4 x 2-1/4
400 -----	600 -----	2, 2-1/2, 3, 7 -----	13/16	13/16	13/16 x 2-5/8	5/8	3/4	3/4 x 2-1/4
600 -----	1,000 -----	(table 3-4)						

¹ For style 2, 2-1/2, 3, 4, 4-1/2 boxes, unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat as specified. Each side and end shall be made from one piece except when the end is approximately square, a two-piece end with each end piece of approximately equal thickness and with the grain of each piece running at right angles to the other may be used. Two-piece ends shall be nailed together with no less than two nails clinched.

² Thickness tolerance is plus or minus 1/16 inch for parts 3/8 inch thick and thicker. Thickness tolerance is plus 1/16 inch, minus 1/32 inch for pieces less than 3/8 inch thick.

³ Width tolerance is plus or minus 1/16 inch.

Table 3-4. Boxes of Oversea Shipment, Type 3 (Difficult) Loads; Minimum Thickness of Sides, Tops, Bottoms, and Ends; and Thickness and Width of Cleats

Weight of contents		Style of box ¹	Groups I and II woods			Groups III and IV woods		
Exceeding	Not exceeding		Thickness of sides, tops and bottoms ²	Thickness of ends ²	Thickness ² and width ² of cleats	Thickness of sides, tops and bottoms ²	Thickness of ends ²	Thickness ² and width ² of cleats
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
0 -----	100 -----	4, 4-1/2, 5 -----	1/2	3/4	3/4 x 2-1/4	1/2	5/8	5/8 x 1-3/4
0 -----	100 -----	2, 2-1/2, 3, 7 -----	1/2	5/8	5/8 x 2-1/4	1/2	5/8	5/8 x 1-3/4
100 -----	250 -----	4, 4-1/2, 5 -----	5/8	3/4	3/4 x 2-5/8	1/2	3/4	3/4 x 2-1/4
100 -----	250 -----	2, 2-1/2, 3, 7 -----	5/8	5/8	3/4 x 2-1/4	1/2	5/8	5/8 x 2-1/4
250 -----	400 -----	4, 4-1/2, 5 -----	3/4	1-1/16	1-1/16 x 3-1/4	5/8	13/16	13/16 x 2-3/4
250 -----	400 -----	2, 2-1/2, 3, 7 -----	3/4	3/4	1-1/16 x 3-1/4	5/8	3/4	3/4 x 2-3/4
400 -----	600 -----	2, 2-1/2, 3, 7 -----	13/16	13/16	1-1/16 x 3-1/4	3/4	13/16	13/16 x 2-3/4
600 -----	800 -----	2, 2-1/2, 3, 7 -----	13/16	1-1/16	11/16 x 3-1/4	3/4	13/16	13/16 x 2-3/4
800 -----	1,000 -----	2, 2-1/2, 3, 7 -----	1-1/16	1-5/16	1-5/16 x 4-1/8	13/16	1-1/16	1-1/16 x 3-3/8

¹ Style 2, 2-1/2, 3, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat as specified. Each side and end shall be made from one piece except when the end is approximately square, a two-piece end with each piece of approximately equal thickness and with the grain of each piece running at right angles to the other may be used. Two-piece ends shall be nailed together with no less than two nails clinched.

² Thickness tolerance is plus or minus 1/16 inch for parts 3/8 inch thick and thicker. Thickness tolerance is plus 1/16 inch, minus 1/32 inch for pieces less than 3/8 inch thick.

³ Width tolerance is plus or minus 1/16 inch.

for interior battens except that the bottom battens shall be fabricated from one piece of lumber a minimum of 2 1/2 inches high and 3 1/2 inches wide.

(4) *Diagonals* (fig 3-12). Sometimes diagonal reinforcing members are added to the interior or exterior surfaces of the box. Diagonals used on both the end and side panels are the same width and thickness as required for cleats and are nailed in the same manner.

(a) The presence of intermediate battens or cleats, required by table 3-6, determine the number of single diagonals on each panel.

(b) Single diagonals in each of two adjacent areas of one panel are arranged to peak at the

center and bear at the upper end of the intermediate batten.

(c) Three or more diagonals in adjacent areas of one panel are arranged in a zigzag manner.

(d) When a 24-inch minimum strapping interval is required, the inner surface of the exterior diagonals must be notched slightly to permit the strapping to pass under each diagonal.

(5) *Skids*. Boxes (except style 7) with items packed therein, having a gross weight in excess of 200 pounds, or containers with length and width dimensions of 48 inches by 24 inches or more and weighing more than 100 pounds, shall be provided

Table 3-5. Number of Pieces in Any Box Part

Width of box part		Maximum number of pieces single solid or built-up
Exceeding	Not exceeding	
Inches	Inches	
0	2-1/2	1
2-1/2	5	2
5	7-1/2	3
7-1/2	12	4
12		(See note)

Note. The width of pieces in box parts exceeding 12 inches shall not average less than 3 inches. No single solid or built-up piece shall be less than 2-1/2 inches when measured across the face.

with a minimum of two skids. The skids shall be fabricated from one piece of lumber of 2 1/2 inches high and 3 1/2 inches wide. Skids shall replace exterior battens on box bottoms when battens are required in table 3-6. Skids shall be placed parallel to and extend the full width of the box and shall be positioned not closer than 2 1/2 inches nor more than one sixth the length of the box from each end of the box. The distance between skids, measured between the inside edges, shall not exceed the distance between battens, and when battens are not required, shall not exceed 48 inches. Additional skid(s), as required, shall be positioned so as to divide the distance between the end skids into units of equal length. When bolt fastening is provided for the item being packed, additional skids, as needed, shall be located on the box bottom so as to enable the item to be bolted through the skids. The skids shall be notched as applicable to provide clearance for either girthwise or lengthwise strapping. When 4-way fork entry is required, skids shall be a minimum of 3 1/2 inches high and 3 1/2 inches wide, cut out a minimum of 2 inches, in depth and of such width as to accommodate forks and slings for handling, and may be placed lengthwise flush with the box sides. The skids shall be secured to the box by nails. The nails shall be driven from the inside through the bottom into the skids and be clinched not less than 1/8 inch. Alternative to clinching, nails conforming to type II, style 18 of FF-N-105 may be used of such length as to penetrate a minimum of 3/4 the thickness of the skids and shall not protrude through the skid. The nails shall be arranged in two rows in a staggered pattern, with spacing between nails in each row not to exceed 6 inches. Nails shall not be located less than 1/2 inch from edges of the skid nor less than approximately 1 1/2 inches from ends of the skid. Variation in specified thickness of skids may be plus or minus 1/8 inch and the variation in specified width of skids may be plus or minus 1/4 inch. When skids are specified and box requires 2 or more inside

battens (table 3-6), the inside bottom battens need not be applied. However, a skid shall be attached to the outside of the box bottom placed in alignment with each side batten.

(6) Nailing requirements.

(a) *Spacing and sizes.* Nail spacing and sizes will conform to tables 3-8 and 3-9.

(b) *Nailing of top and bottom.* When specified, the top and bottom should be nailed to the box sides.

(c) *Nail sizes.* Sizes of nails are determined from the following information:

1. Nail sizes for fastening sides, top, and bottom to ends and cleats are determined by the group of wood and thickness of the pieces being fastened together (table 3-7).

2. Nail sizes to secure top and bottom to the sides are determined from the group of wood being used and the thickness of the side (table 3-8).

3. Nails to fasten cleats to the ends will be long enough to penetrate both the cleat and the end and be clinched at least one-eighth of an inch. However, when eightpenny nails or smaller are used, they may be clinched not more than three-eighths inch.

4. If the correct nail size is not available, or splitting is encountered, one size smaller is used, and the spacing will be one-fourth of an inch closer.

(d) *Nail spacing.* The spacing of nails is determined from the following:

1. Nail spacing for fastening sides, top, and bottom to the ends will depend on the size of nails used, and whether driven into side-grain or end-grain. If nails are driven into both side- and end-grain, the spacing is the same as for end-grain nailing (table 3-9).

Table 3-6. Requirements for Additional Battens or Cleats

Thickness of ends, side, top, or bottom		Length of unsupported span
Groups I and II woods	Groups III and IV woods	
Inches	Inches	Inches
	1/4	19
3/8		21
	3/8	23
1/2		30
	1/2	34
5/8		38
	5/8	42
	3/4	47
1		50
	13/16	54
1-1/4	7/8	64

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2. Nail spacing for fastening the top and bottom to the sides of the box is determined from the thickness of the sides. If the thickness of sides is less than three-fourths of an inch, no nailing is permitted. There is a minimum and maximum spacing (table 3-8).

3. When attaching cleats and battens, the nails are driven in two parallel rows spaced alternately as given in table 3-9, so that the end nails are not less than three-fourths of an inch from the end of the cleat or batten. All nails shall pass through both the cleat and the end (or batten and side, top and bottom) and be clinched. Nails are driven approximately three-eighths of an inch from the edge when the cleat or batten is 2 inches or under in width, and one-half of an inch when it is over 2 inches in width.

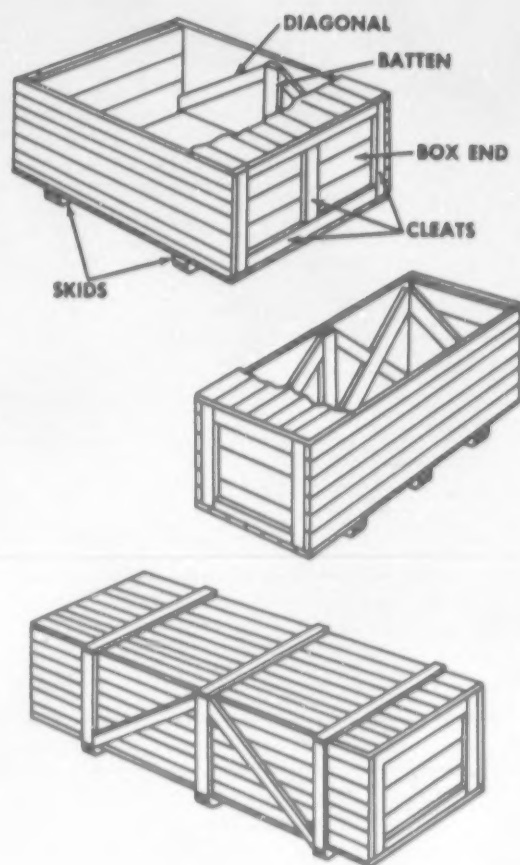
(e) *Nailing rules.* It is imperative that poor nailing practices be avoided and correct nailing procedures be followed. Both are shown in figures 3-13 and 3-14, and stressed in the following rules:

1. Each single solid piece or built-up piece in the sides, top, or bottom will have at least two nails or other acceptable fastener at each end.

2. Each single piece or built-up piece is fastened to each vertical cleat or batten with not less than two nails or other acceptable fastener.

3. Wherever possible, side-grain nailing should be accomplished. In nailing to both the end and the cleats, at least half of the nails are driven into the cleat.

4. Where a cleat is attached to an end, at least one end nail will be adjacent to the inside edge of the cleat.



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Figure 3-13. Style 2 reinforced wood box.

Table 3-7. Size of Cement-coated or Chemically-etched Cooler, Sinkers, and Standard Box Nails for Boxes

Species of wood	Size of nail (penny)	Thickness of ends of cleats to which sides, tops and bottoms are nailed										
		Exceeding	7/16	1/2	9/16	5/8	11/16	13/16	3/4	1	1-1/8	1-1/4
		Not exceeding	7/16	1/2	9/16	5/8	11/16	13/16	3/4	1	1-1/8	1-1/4
Group I	4	4	5	5	6	7	8	8	9	9	10	12
Group II	4	4	4	5	5	6	7	7	8	9	9	12
Group III	3	4	4	5	5	6	7	7	8	8	9	10
Group IV	3	3	4	4	4	5	6	6	7	8	8	9

Table 3-8. Size of Nails and Spacing for Nailing Tops and Bottoms to Sides of Boxes

Thickness of side (inches)	Group I wood	Group II wood	Groups III and IV wood	Spacing (inches)	
				Minimum	Maximum
Under 3/4	No nailing permitted				
3/4 thru 7/8 incl	7d	6d	5d	6	8
15/16 thru 1-1/16 incl	8d	7d	6d	6	8
Over 1-1/16	10d	9d	8d	8	10

Table 3-9. Spacing of Nails

Size of nails	Spacing when driven into side grain	Spacing when driven into end grain
	Inches	Inches
Sixpenny or smaller	2	1-3/4
Sevenpenny	2-1/4	2
Eightpenny	2-1/2	2-1/4
Ninepenny	2-3/4	2-1/2
Tenpenny	3	2-3/4
Twelvepenny	3-1/2	3
Sixteenpenny	4	3-1/2
Twenty penny	4-1/2	4

When nails are alternately driven into end-grain of end and side-grain of cleat (such as nailing sides to ends in Styles 2, 2-1/2, 3, 4, 4-1/2, 5 and 7) use spacing based on driving nails into end-grain.

5. Nails are clinched across the grain of the wood, if possible.

6. Nails must be driven so that neither the head nor the point will project above the surface of the wood.

7. Occasionally, overdriven nails are permitted. Nails overdriven more than one-eighth the thickness of the piece are not permitted.

8. Cement-coated or chemically-etched nails have a holding power considerably greater than that of uncoated and consequently 25 percent more nails of the same size are needed when smooth nails are used in place of cement-coated or chemically-etched nails. The comparative holding power of nails is illustrated in figure 3-15. Bright, uncoated nails must be clinched.

f. Setting up of Style 1 and 6 Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and glue.*

(a) Size of coated and etched nails and proper spacing is determined from tables 3-7, 3-8, and 3-9.

(b) Glue for securing sides to ends of Style 6, lock-corner box, is any commercially available water-resistant glue.

(2) *Fasten the sides to the ends.*

(a) Fasten the sides to the ends by straight-line nailing, using cement-coated or chemically-etched nails.

(b) Apply glue to both surfaces of the sides and ends of the lock-corners of Style 6 boxes.

(3) *Nail the top and bottom.*

(a) Use nails and proper spacing determined in (1) above.

(b) Secure the bottom of the box by nailing into the ends.

(c) After the load is inserted, secure the top of the box in the same manner as the bottom.

g. Setting up of Style 2, 2-1/2, and 3 Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and proper spacing.* Select proper size and spacing of coated or etched, and bright, uncoated nails from tables 3-7 and 3-8.

(2) *Fasten the cleats to the ends.*

(a) Nail cleats to end, using a staggered nailing pattern.

(b) Nails for nailing cleats to ends may be bright, uncoated, but must be clinched.

(c) Position the vertical cleats on the end at right angles to the grain of the end.

(3) *Fasten the sides to the ends.*

(a) Lap the sides over the ends and cleats.

(b) Nail the sides to the ends and cleats with coated or etched nails in a staggered pattern.

(4) *Nail the top and bottom.*

(a) Lap the top and bottom over the ends and cleats.

(b) Nail the top and bottom to the ends and cleats with coated or etched nails in a staggered pattern.

h. Setting up of Style 4, 4-1/2, 5, and Shallow Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and proper spacing.* Select the proper size and spacing of coated or etched, and bright, uncoated nails from tables 3-7, 3-8, and 3-9.

(2) *Fasten the cleats to the ends.*

(a) Nail the cleats to the end using a staggered nailing pattern (para 3-2e(6)).

(b) Nails for nailing the cleats to the ends may be bright, uncoated, but must be clinched.

(3) *Fasten the sides to the ends.*

(a) Lap the sides over the ends and cleats on Style 4 and 5 boxes.

(b) Fasten the sides to the ends and cleats in a staggered nailing pattern.

(c) Lap the sides of Style 4-1/2 and shallow box over the ends.

(d) Drive the nails in a straight line for Style 4-1/2 box and in a staggered pattern for shallow boxes.

(4) *Nail the top and bottom.*

(a) Nail the bottom of the box to the ends and sides.

(b) On style 4 and 5, boxes nail the top and bottom to the end with straightline nailing.

(c) On Style 4-1/2 and shallow boxes, nail the

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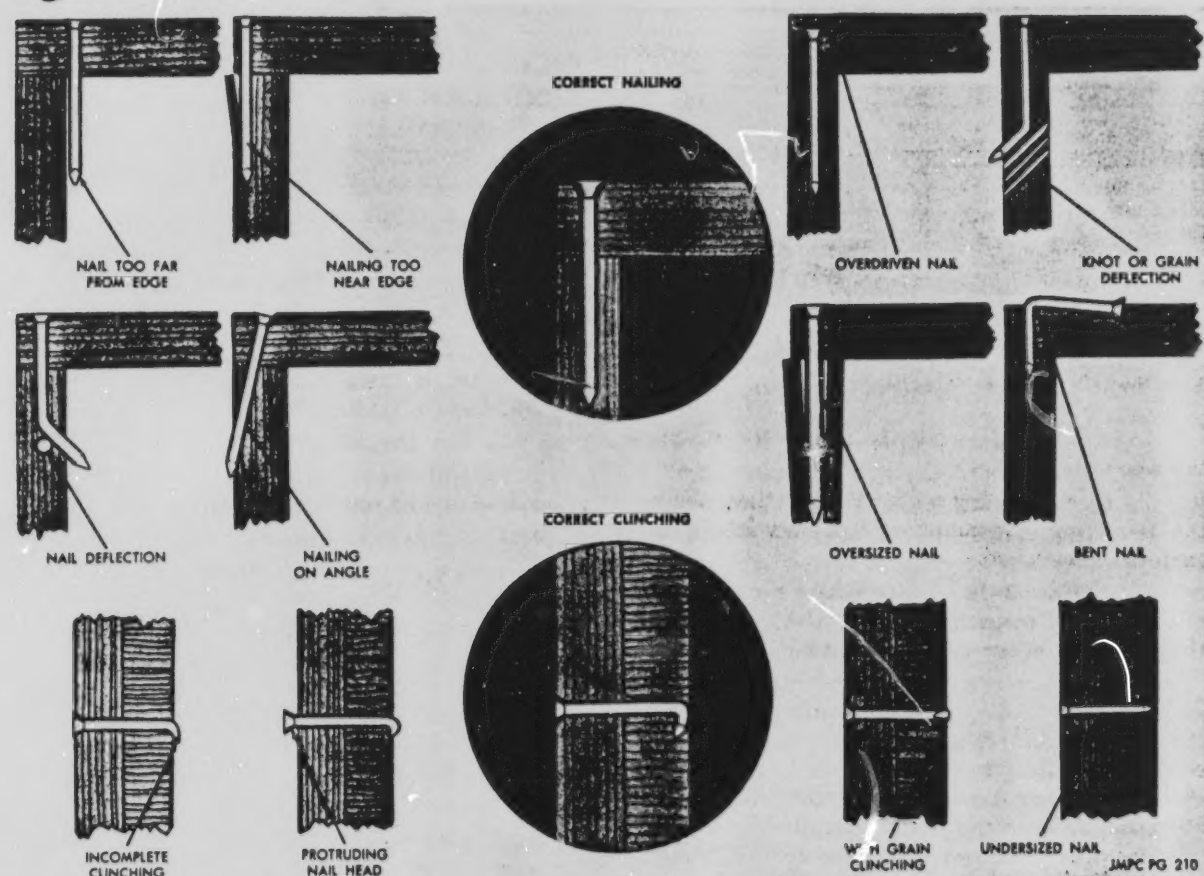


Figure 3-13. Nailing—avoid poor practices.

top and bottom to the ends with a staggered nailing pattern.

i. *Strapping Requirements.* Strapping used on nailed wood boxes may be either round or flat (para 3-1b(6)). Proper size of strapping is determined by the net weight of contents and the number of straps used (tables 3-10 and 3-11). All straps are applied perpendicular to the edges of the box over which they pass and are drawn tight so as to sink into the wood at the edges. Straps shall be applied just prior to shipment where practicable. Strapping requirements are found in the Appendix to Specification PPP-B-621.

(1) *Class 1 (domestic) boxes.* Unless otherwise specified, Style 1 and 6 boxes, regardless of weight, and Style 2 $2\frac{1}{2}$, 3, 4, $4\frac{1}{2}$, 5 and 7 boxes, with weight of contents exceeding 100 pounds, shall be strapped. When specified, Style 2, $2\frac{1}{2}$, 3, 4, $4\frac{1}{2}$, and 5 boxes, with weight of contents less than 100 pounds, shall be strapped.

(2) *Class 2 (oversea) boxes.* All boxes used for a shipment intended for overseas shall be strapped (fig 3-16).

(3) *Placement of straps.*

(a) On most boxes, the first straps are positioned girthwise about one-sixth of the length of the box from each end, not to exceed 9 inches from the ends.

(b) On styles 1 and 6, the first strap is lengthwise, followed by girthwise straps.

(c) When strapping is required on Style 7 boxes, one strap is applied parallel to, and immediately adjoining the inner edge of each skid. Three or more straps, equally spaced, are required when spacing between straps exceeds 24 inches.

(d) Additional straps are placed girthwise so that the distance between straps does not exceed 24 inches.

(e) Small boxes less than 12 inches long and having less than 35 pounds of contents require

Table 3-10. Minimum Gage of Round Wire for Various Weights of Boxes

Net weight of contents		Gage of wire when different number of wires are used			
		Two bands		Three or more bands	
Exceeding	Not exceeding	Class B	Class A	Class B	Class A
Pounds	Pounds	Inch	Inch	Inch	Inch
0 -----	70 -----	0.0720 (15 gage) ----	0.0625 (16 gage) ----	0.0720 (15 gage) ----	0.0625 (16 gage)
70 -----	125 -----	0.0800 (14 gage) ----	0.0720 (15 gage) ----	0.0800 (14 gage) ----	0.0720 (15 gage)
125 -----	175 -----	0.0915 (13 gage) ----	0.0800 (14 gage) ----	0.0915 (13 gage) ----	0.0800 (14 gage)
175 -----	250 -----	0.0915 (13 gage) ----	0.0915 (13 gage) ----	0.0915 (13 gage) ----	0.0915 (13 gage)
250 -----	400 -----	0.1055 (12 gage) ----	0.0990 (12-1/2 gage) ----	0.0915 (13 gage) ----	0.0915 (13 gage)
400 -----	1,000 -----	-----	-----	0.1055 (12 gage) ----	0.0990 (12-1/2 gage)

Table 3-11. Minimum Sizes of Flat Metal Bands for Various Weights of Boxes

Net weight of contents		Dimensions of flat metal bands when different numbers of bands are used	
		Two bands	Three or more bands
Exceeding	Not exceeding		
-----	70 -----	3/8 by 0.015	3/8 by 0.015
70 -----	125 -----	3/8 by 0.020	3/8 by 0.020
125 -----	175 -----	1/2 by 0.020	1/2 by 0.020
175 -----	250 -----	5/8 by 0.020	5/8 by 0.020
250 -----	400 -----	3/4 by 0.020	3/4 by 0.020
400 -----	1,000 -----	-----	3/4 by 0.023

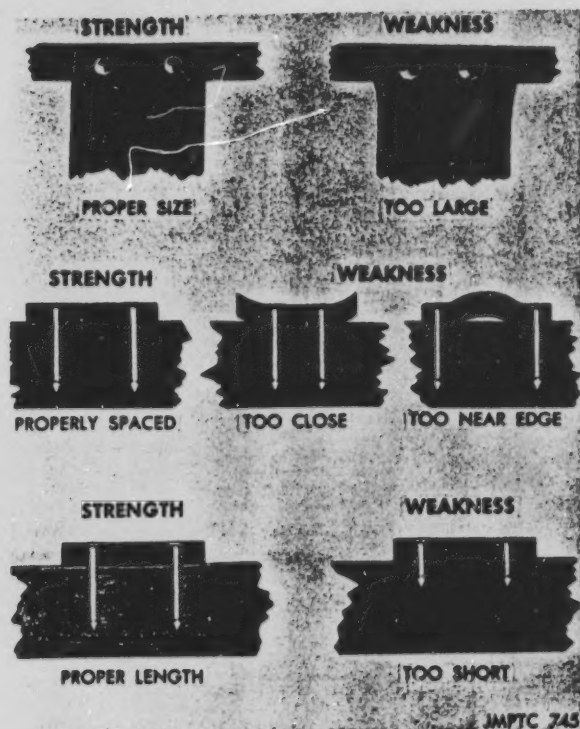


Figure 3-14. Proper and improper nailing.

only one girthwise strap. The single girthwise strap may be 16 gage round wire, or $\frac{3}{8} \times 0.010$ -inch flat strap.

(f) A minimum of three girthwise straps are required when the weight of the contents exceeds 400 pounds regardless of length.

j. *Workmanship.* Throughout the fabrication, setting up, nailing, and strapping of nailed wood boxes, good workmanship should be practiced at all times. Figure 3-17 shows some of the defects which must be avoided.

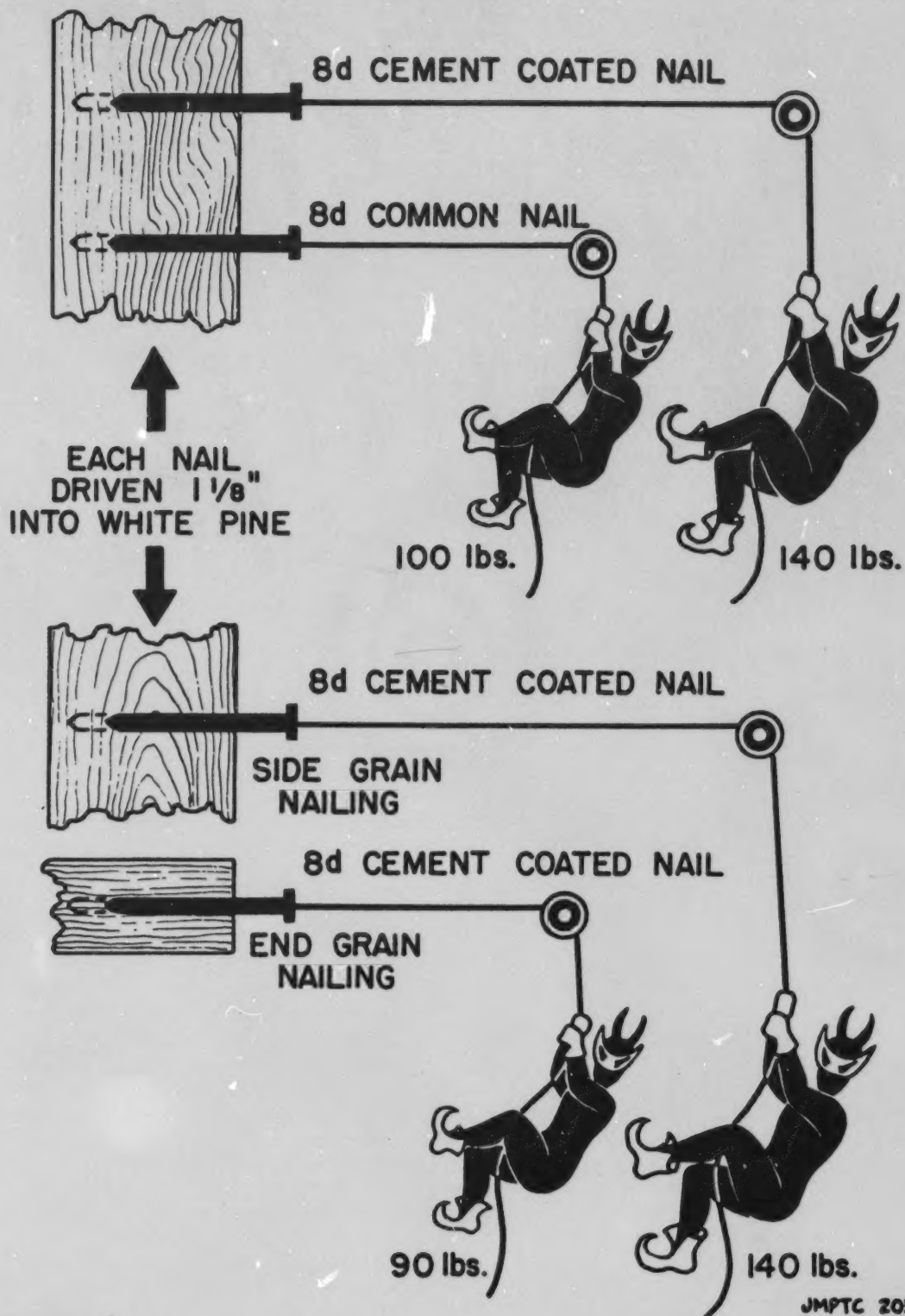
k. *Preservation.* When specified (c(2) above) each box, or all of the finished wood parts shall be preserved by immersing for a minimum of one minute in wood preservative conforming to composition A (pentachlorophenol) of TT-W-572. When procured, the box parts in the knockdown shook form, or complete box, must be dry after preservation. Dryness can be determined by the absence of discoloration of the red oil soluble dye when tested as specified in PPP-B-621.

3-3. Cleated Panel Boxes (General)

a. *Description.* Cleated panel boxes are made by attaching wood cleats to sheets of plywood, fiberboard or paper overlaid veneer, to form panels that are later fastened together at the cleats to form a container. When plywood is used as panel material, they are called wood cleated plywood boxes, Specification PPP-B-601; when fiberboard is used, they are called wood cleated fiberboard boxes, Specification PPP-B-581; and when paper overlaid veneer is used, they are called wood cleated paper overlaid veneer boxes, Specification PPP-B-576. In each type of box, the cleats act to reinforce the edges and to aid in nailing.

b. *Characteristics.* The chief characteristics of cleated panel boxes are: Lightweight, high resistance to diagonal distortion, resistance to corner

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Figure 3-15. Nail holding power.

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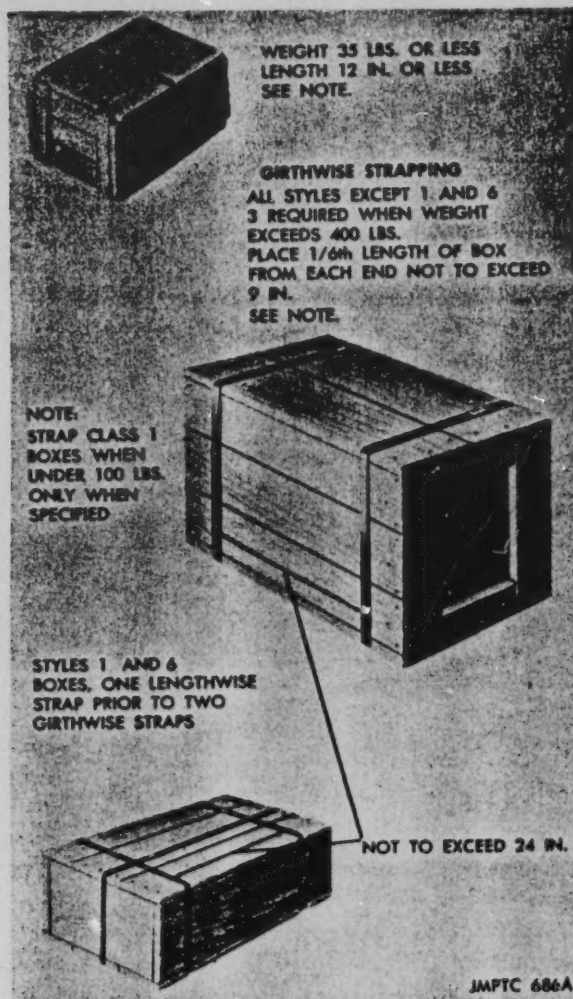


Figure 3-18. Strapping of nailed wood boxes.

damage, and ability to withstand severe tumbling and dropping. They are easy to mark and handle, almost dustproof, and lend themselves to easy fabrication. Panels may be bought in large quantities in the knocked-down form, which can be easily stored in a minimum of space. These boxes afford three choices of cleated panel boxes for use in the shipping of military supplies and equipment. Selection of the panel material for the box is based upon the destination of the shipment, the minimum protection required, the weight of the item, and the container limitations.

c. Intended Uses and Limitations. The styles of boxes permitted for domestic and overseas shipments, with limitations for cleated plywood, cleated fiberboard, and cleated paper overlaid veneer boxes are cited in table 3-12.

(1) *Overseas type boxes.* Styles A and B are the

only ones permitted, for cleated fiberboard and veneer. Cleated plywood boxes permit Styles A, B, I, and J. Plywood and paper overlaid boxes will take all three types of loads. Cleated fiberboard boxes will take Type 1 and 2 loads only. Style A lends itself to ease of assembly and opening. Style B has greater strength, but is more difficult to open. The designs of these boxes and their load limit for overseas shipments are given in the respective container specifications.

(2) *Domestic type boxes.* Domestic boxes are intended for normal use when the additional strength of the overseas type is not required (fig 3-19). The selection of the style depends largely on the nature and weight of the item, and how it is to be supported. Styles B, D, E, and G have 3-way corners and are satisfactory if the boxes are not to be opened for inspection and reclosed. If the boxes

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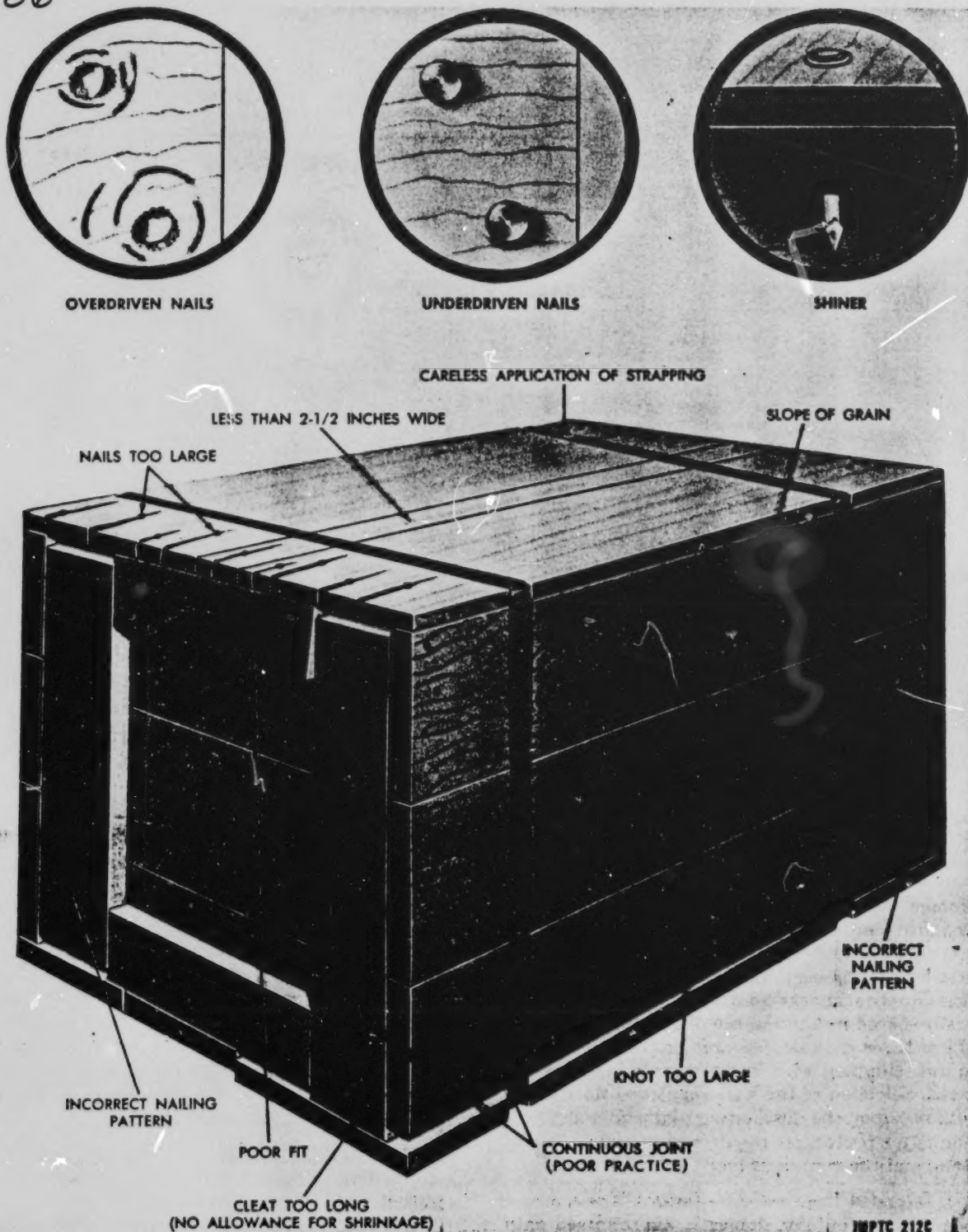
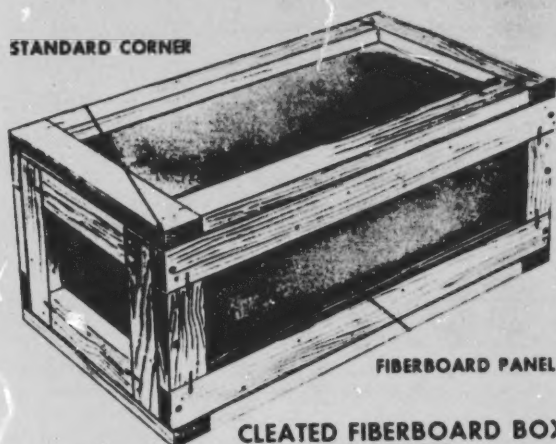


Figure 3-17. Defects of railed wood boxes.

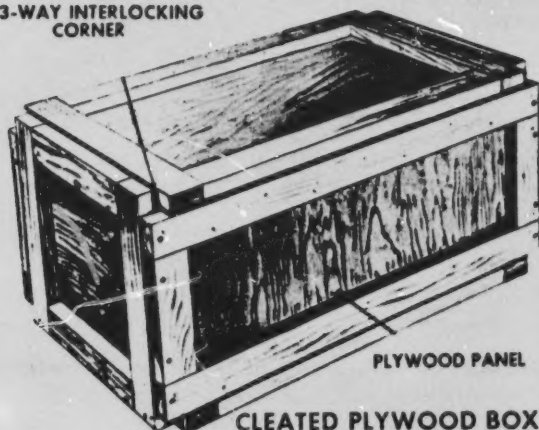
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STANDARD CORNER



FIBERBOARD PANEL

CLEATED FIBERBOARD BOX
STYLE A

3-WAY INTERLOCKING
CORNER


PLYWOOD PANEL

CLEATED PLYWOOD BOX
STYLE B

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Figure 3-18. Oversea styles of cleated panel boxes.

are to be opened and reclosed, Style A and K are preferred. The full-cleated Styles A and B are the strongest and most suitable for heavy items, if the weight can be applied over the entire area of any face. Styles A and B require only one size of nails for assembling the box, whereas, two sizes of nails are required for Styles C and K, inclusive. Paper overlaid veneer boxes are only available in Styles A and B for domestic shipment. All three types of loads are permitted, except for wood cleated fiberboard boxes, where Type 3 loads must be converted to either Type 1 or 2.

3-4. Cleated Plywood Boxes (PPP-B-601)

a. Construction of Panels. Plywood will conform to the minimum commercial standard grades in table 3-13. Plywood for domestic boxes will con-

form to PS-51, Type III and PS-1, Standard Interior. Plywood for oversea boxes will conform to PS-51, Type I and PS-1, Standard Interior with exterior glue (see table 3-14, 3-15). If it is known that the boxes will not be exposed to the weather during storage and handling to its final oversea destination, plywood as specified for domestic type boxes should be specified. Cleated plywood boxes are classified as Grade A, with preservative treatment, and Grade B, without preservative treatment. Plywood and cleats for Grade A boxes shall be treated with water-repellent preservative conforming to Specification TT-W-572, Composition A (pentachlorophenol). Shipments of subsistence and clothing shall not be made in boxes fabricated from toxic treated plywood. If smooth finish or sanded panels are required, appropriate sanded grades should be specified. The minimum thickness of the plywood and size of cleats should be as shown in tables 3-14 or 3-15, as applicable. The plywood is attached to the cleats in the following manner:

(1) *Arrange the cleats.*

(a) Each panel for Styles A and B will have two through cleats and two filler cleats.

(b) Position the through cleats opposite each other at the edges of the panel material; then position the filler cleats between the through cleats at the edges.

(c) Unless otherwise specified (d and e below) filler edge cleats shall be either the same length as the distance between the through edge cleats, or approximately $\frac{1}{8}$ -inch shorter.

(d) Filler edge cleats on top and bottom panels, except on top only when the box is provided with skids, shall be either the same length as the distance between the through edge cleats or approximately $\frac{1}{4}$ inch shorter for overseas type boxes.

(e) When the filler cleats are the same length as the distance between through edge cleats, each end shall be either cut at an angle or notched to provide a drainage area between the filler cleat and the plywood of approximately $\frac{1}{4}$ inch by $\frac{1}{4}$ inch.

(f) Each cleat shall be a single unjointed piece.

(2) *Fasten the panel material to the cleats (fig 3-20).*

(a) Nails, staples, wire stitches, or other fasteners positioned lengthwise of a cleat are staggered in two parallel rows, approximately three-eighths inch from the edges of the cleat.

(b) The distance between the nearest edge of a fastener and the edge of a cleat shall not be

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Table 3-12. Comparison of Cleated Panel Boxes

Items of comparison	Cleated plywood (PPP-B-401)	Cleated fiberboard (PPP-B-591)	Paper overlaid veneer (PPP-B-576)
Styles	A through K	A through K	A and B
Class of use	1 and 2	1 and 2	1 and 2
Styles, oversea	A, B, I and J	A and B	A and B
Styles, domestic	A through K	A through K	A and B
Weight limit vs. styles	Oversea A and B—1,00# Domestic A and B—1,000# C through K—150#	A and B 200# A and B—400# C through K—150#	A and B—350# A and B—400#
Types of loads vs. weight	1, 2 and 3	1 and 2	Type 1—2 Domestic 400# Type 3—Domestic 300# Type 1—2 Overseas 350# Type 3—Overseas 250#
Unsupported span for intermediate cleats, maximum.	Type 1 and 2 loads—24" Type 3 load—20"	Type 1 and 2 loads—20" Domestic—24"	Type 3 load, Class 2 use—20" All other—24"
Size limit	Oversea No size limit Domestic No size limit	4' x 3' x 3' No size limit	No size limit No size limit
Strapping	Styles A and B 2 lengthwise straps, and strap over all intermediate cleats, except cleats located on ends of plywood containers Styles C thru K Consult Appendix of Specification	No strap on veneer boxes Class 1 use under 150	
Staples	4" maximum from corners, approximately 6" apart thereafter (except over bands on bottom of box for plywood)		

less than $\frac{3}{8}$ -inch and not closer than $\frac{3}{4}$ -inch from the end of the cleat.

(c) Space the nails not more than 6 inches apart lengthwise in each row.

(d) Space staples not more than 7 inches apart in each row.

(e) Usually, nail or staple through the plywood and then cleat and clinch. Reversal of this sequence is permitted only for nails.

b. *Construction of Plywood Joints.* In the construction of large cleated plywood boxes, it frequently becomes necessary to join sheets of panel material. Bottom panels of boxes not exceeding 72 inches in length or 48 inches in width, and top and bottom panels of style I boxes shall consist of a single piece of plywood. All other panels shall consist of one or two pieces of plywood joined by either a lap or butt joint (fig 3-21) as specified in (1) and (2) below. Each piece of plywood in two piece panels shall be not less than 24 inches in length or width. Plywood joints in adjacent panels should not be closer than 12 inches of being in line.

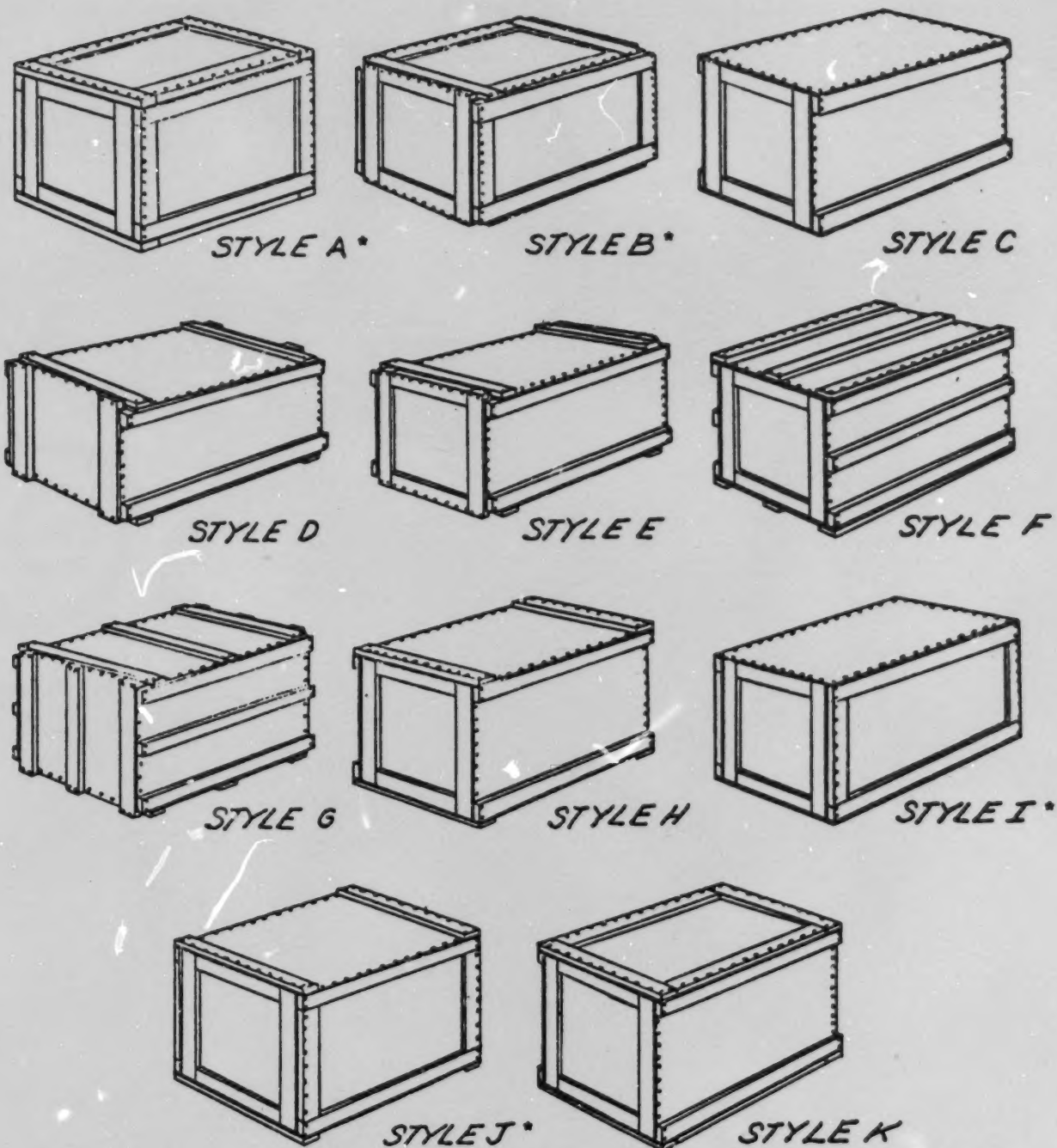
(1) *Lap joint.* Overlap two pieces of panel material at least 3 inches. Fasten the sheet together with metal stitches through the overlap

and clinch. Use not less than two parallel rows of stitches. Space stitches not less than 2 inches apart. The average spacing of stitches in each row must not exceed 4 inches. The maximum thickness of plywood to be used for this type of joint shall be $\frac{3}{16}$ inch.

(2) *Butt joint.* Butt two pieces of plywood at the midwidth of a joint cleat. Fasten each piece of plywood to the joint cleat. The thickness of a joint cleat will be the same as an edge cleat. The width of a joint cleat for a domestic box will be no less than $2\frac{1}{4}$ inches. If the edge cleat is more than $2\frac{1}{4}$ inches wide, the joint cleat will be of the same width. For oversea type boxes, the joint cleat will be not less than $1\frac{1}{2}$ times the required width of the edge cleats or never less than $2\frac{1}{4}$ inches.

(1) *Determine the requirements.* Additional wood cleats, of the same width and thickness as the edge cleat, are applied to an unframed area which exceeds 24 inches in any dimension or 20 inches for oversea type boxes with Type 3 loads. Additional cleats are applied to any face of a box having a load concentration near the center of the unframed area.

(2) *Fasten the cleats.* Apply cleats perpendicular to the greater of the two dimensions between



NOTE: ALL ELEVEN STYLES CAN BE USED FOR DOMESTIC USE.

* ONLY STYLES A, B, I, AND J CAN BE USED FOR OVERSEA USE.

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Figure 3-19. Styles of cleated panel boxes.

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Table 3-13. Plywood, NN-P-530, Commercial Standards 1¹, 2²

Box type	PS-31	Group B PS ¹
Domestic	Type III, grade 3-4 veneers	C-D.
Overseas	Type I, grade 3-4 veneers	C-D, with exterior glue.

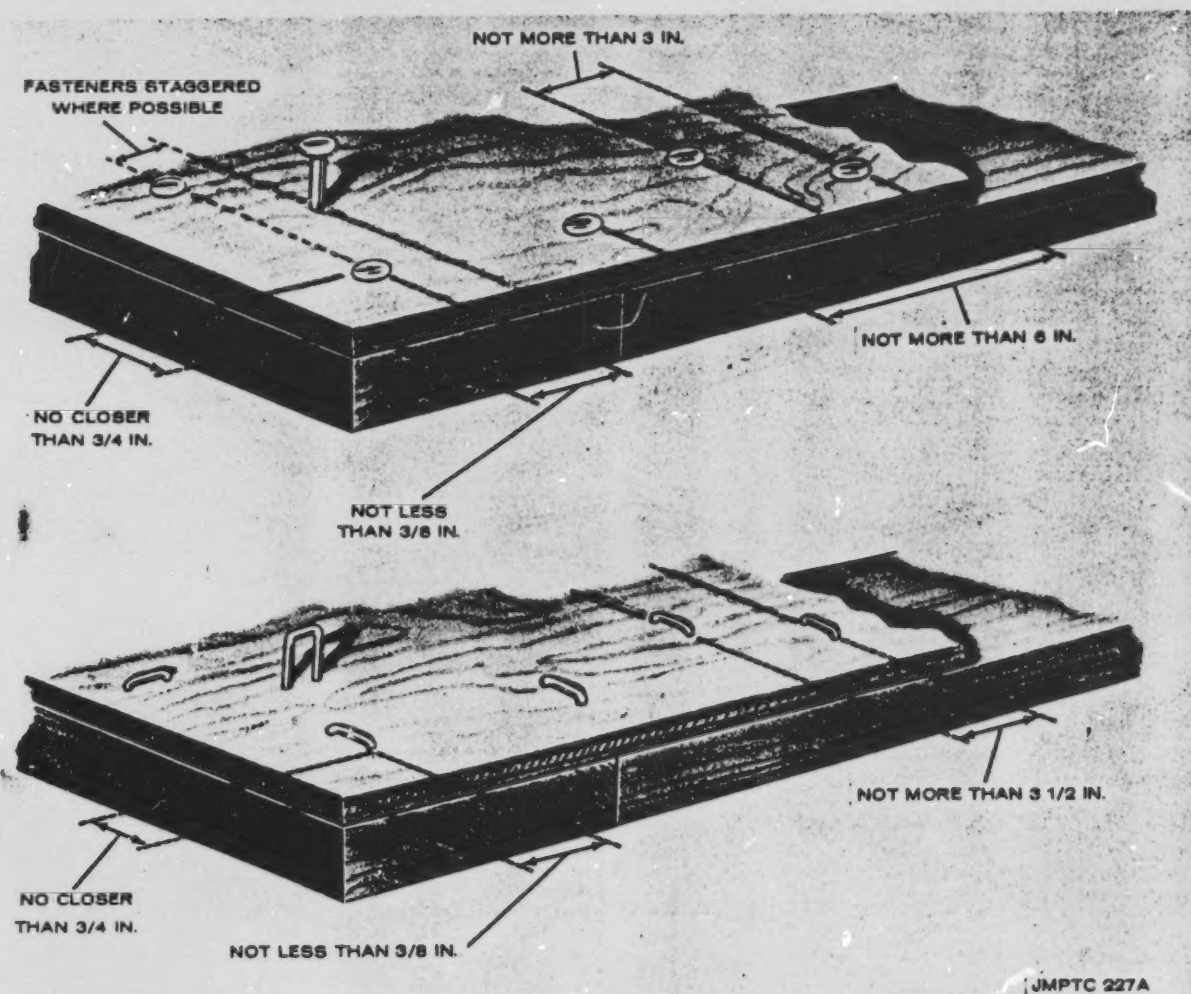
¹ Plywood is furnished unsanded. If smooth finish or sanded panels are required, appropriated sanded grades should be specified in the contract or order.² End grain butt joints shall be prohibited for grade 4 veneers.

Figure 3-20. Spacing of fasteners.

edge cleats. Space and drive fastenings in the same manner as for edge cleats.

d. Assembly of Boxes.

(1) Style A (oversea)

(a) *Assembly of the panels.* Arrange the panels so that one through cleat and one filler cleat forms each edge of the box. Arrange the cleats to form a standard box corner (fig 3-18). Arrange the top and bottom panels to overlap the sides and ends.

(b) *Nailing the panels together.* Nail all panels to each other by single line nailing. Use either mechanically deformed, cement-coated or chemically-etched nails. Space the nails in accordance with the type of load and the thickness of cleats (tables 3-16 and 17).

(2) Style B (oversea).

(a) *Assembly of the panels.* Arrange the panels so that one through cleat and one filler cleat forms each edge of the box. Arrange the

Table 3-14. Domestic Type, Requirements for Cleats and Plywood (PPP-B-601)

Style of box	Weight of contents		Minimum thickness of plywood ^a		Size of cleats ¹		
					Thickness		Width
	Exceeding	Not exceeding	PS-1 (table 3-13) ^a	PS-51 (table 3-13) ^a	Groups 1 and 2 woods	Groups 3 and 4 woods	All wood groups (incl)
	Pounds	Pounds	Inch	Inch	Inch	Inch	Inches
A to K incl	0	75	1/8	1/8	5/8	5/8	1-3/8
A to K incl	75	150	3/16 ^a	1/8	3/4	3/4	1-3/4
A, B and I	150	300	3/16 ^a	3/16 ^a	3/4	3/4	1-3/4
A, B and I	300	500	1/4	3/16	3/4	3/4	1-3/4
A, B and I	500	800	5/16	1/4	3/4	3/4	2-1/4
A, B and I	800	1000	3/8	5/16	3/4	3/4	2-5/8

¹ At no place shall the actual thickness be less than the required thickness, minus 1/16 inch, nor the actual width be less than the required width, minus 1/8 inch.

^a Alternatively low density wood plywood conforming to CS-35 (table 3-13) may be used.

^a Low density wood plywood conforming to CS-35 (table 3-13) shall not be used.

^a 3/20 minimum inch thick plywood conforming to Type III, Grade 4 of CS-35, may be used in place of the 3/16 inch plywood (3/20" thick plywood is not standard thickness in CS-35).

^a Except that commercial tolerances shall apply.

^a For domestic shipments in Style I, weight of content in excess of 150 lb use table 3-15. For Air Force shipments the weight limitation of Style I shall be 150 lbs.

Table 3-15. Oversea Type, Requirements for Cleats and Plywood (PPP-B-601)

Weight of contents		Minimum thickness of plywood ^a								Sizes of edge cleats for all groups ¹	
		Types 1 and 2 loads				Type 3 load					
Exceeding	Not exceed- ing	PS-1 (table 3-13) ^a		PS 51 (table 3-13) ^a		PS-1 (table 3-13) ^a		PS 51 (table 3-13) ^a		Thickness	Width
		Style		Style		Style		Style			
		A, B, I & J ^{a, 7}		A, B, I & J ^{a, 7}		A, B, I & J ^a		A, B, I & J ^{a, 7}			
Pounds	Pounds	Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inches
0	100	3/16	3/8	3/16 ^a	5/16	1/4	3/8	3/16	5/16	5/8	1-3/4
100	200	1/4	3/8	3/16 ^a	5/16	1/4	3/8	3/16	5/16	3/4	1-3/4
200	300	1/4	1/2	3/16	3/8	5/16	1/2	1/4	3/8	3/4	1-3/4
300	400	1/4	1/2	3/16	3/8	5/16	1/2	1/4	3/8	3/4	1-3/4
400	500	1/4	1/2	3/16	3/8	5/16	5/8	1/4	1/2	3/4	2-1/4
500	600	5/16	1/2	1/4	3/8	5/16	5/8	1/4	1/2	3/4	2-5/8
600	800	3/8	5/8	5/16	1/2	3/8	5/8	5/16	5/8	3/4	3-1/4
800	1000	3/8	5/8	5/16	1/2	1/2	5/8	3/8	5/8	7/8	3-1/4

¹ At no place shall the actual thickness be less than the required thickness, plus or minus 1/16 inch, nor the actual width be less than the required width plus or minus 1/8 inch.

^a Alternately low density wood plywood conforming to PS 51 may be used.

^a Low density wood plywood conforming to PS 51 shall not be used.

^a Top and bottom panels of I and J boxes only, all other panels as specified for styles A and B.

^a Minimum 3/20 inch thick plywood conforming to type I, grade 4 of PS 51 may be used in place of the 3/16 inch thick plywood (3/20-inch thick plywood is not a standard thickness in PS 51).

^a Commercial tolerances shall apply.

^a The maximum weight of contents for Air Force shipments shall be 150 lbs.

cleats to form a 3-way interlocking corner (fig 3-18). Arrange the top and bottom to overlap the sides; then arrange the ends to overlap the top and bottom and, finally, arrange the sides to overlap the ends.

(b) *Nailing the panels together.* Nail each through cleat to two other through cleats at the corner with nails driven at right angles to each other. Nail the panels to each other by single line nailing. Use either mechanically deformed, cement-coated, or chemically-etched nails. Space the nails in accordance with the type of load and the thickness of the cleats (tables 3-16 and 3-17).

(3) *Styles A through K (domestic).* Eleven

styles are available for domestic use: Styles A through K, inclusive, depending on the cleat arrangement. A study of figure 3-19 shows the cleat arrangement for each style. For Styles C through K, inclusive, the plywood along each uncled edge is fastened to the cleat on the adjacent panel by nails passing through the plywood and into the cleat. Nails shall not be less than 1 inch longer than the thickness of the plywood through which they pass and their spacing shall not exceed 3 inches.

e. *Application of Skids.* Unless otherwise specified, boxes with items packed therein, having a gross weight in excess of 200 pounds or length and

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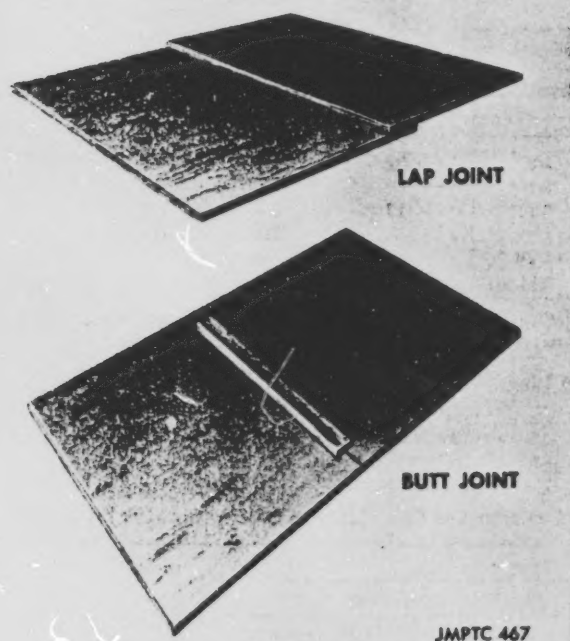


Figure 3-21. Acceptable plywood joints.

width dimensions of 48 inches by 24 inches or more, and gross weight of 100 pounds or over, shall be provided with a minimum of two skids. The skids shall be a minimum of 2½ inches high and 3½ inches wide. When 4-way fork entry is required, skids shall be nominal 4-by-4-inch, placed lengthwise not less than 1½ inches nor more than 2½ inches from the container sides and cut out a minimum of 2 inches in depth and of such width as to accommodate forks and slings for handling. Each skid shall be notched sufficiently to provide clearance for strapping. The skids shall be placed parallel to, and extend the full width of the box (the shorter of the two horizontal dimensions), and shall be set not less than 2½ inches nor more than ⅓ the box length from each end. The distance between skids, measured between the inside edges, shall not exceed 48 inches. Filler cleats of the same thickness as the end cleats of the bottom panel and not less than the width of the skids shall be provided between each skid and the bottom panel of the shipping container. Additional skid(s), as required, shall be positioned so as to divide the area between the end skids into units of equal lengths. When boltholes are provided in the item, additional skids if needed, shall be located so as to enable the item to be bolted to the skids. The skids shall be secured to the box by nails. The nails shall be driven through the bottom panel, the filler cleats, and the skids, and

shall penetrate a minimum of ¾ the skid thickness. The nails shall be pallet nails having mechanically deformed shanks conforming to FF-N-105. These nails shall not protrude through the bottom surface of the skid. The nails shall be arranged in two rows in a staggered pattern, with spacing between nails in each row to be not more than 6 inches. Each row of nails shall be approximately ½ inch in from the edge of the skid, and the nailing pattern shall begin and end approximately 1½ inches in from the end of each skid and shall not be nailed through the strap notch.

Table 3-16. Domestic Type, Sizes and Spacing of Nails for Fastening Together Adjacent Cleated Panels

Cleats, thickness (Inch)	Nails, spacing, (maximum)	Size of nails for wood groups ¹		
		I and II	III	IV
	Inches	Penny	Penny	Penny
5/8	5	6	8	5
3/4	4	7	7	6

¹ If the nail protrudes through the last edge cleat, then the next smaller size penny nail shall be used.

f. Closure. The top panel shall be positioned and nailed. The size and spacing of nails shall be shown in table 3-16 and 3-17. Drive nails straight to prevent them from protruding.

g. Strapping Requirements. Strapping requirements are found in the appendix to Specification PPP-B-601. The sizes of round wire and flat metal straps are found in tables 3-18, 3-19, and 3-20.

(1) *Styles A, B, I and J (oversea).*

(a) Strap Styles A, B, I and J, unless otherwise specified (fig 3-23).

(b) On Styles A and B, apply two lengthwise straps on the edge cleats over the ends, top, and bottom.

(c) On Style I, apply two lengthwise straps on the edge cleats over the ends and sides.

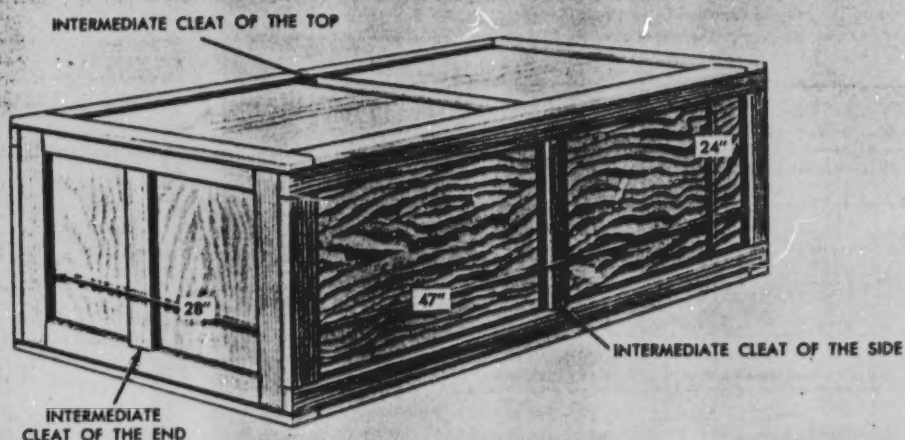
(d) Place a girthwise strap over intermediate cleats, when required, on the sides, top and bottom.

(e) Draw strapping tightly so as to sink into the edges of the cleats.

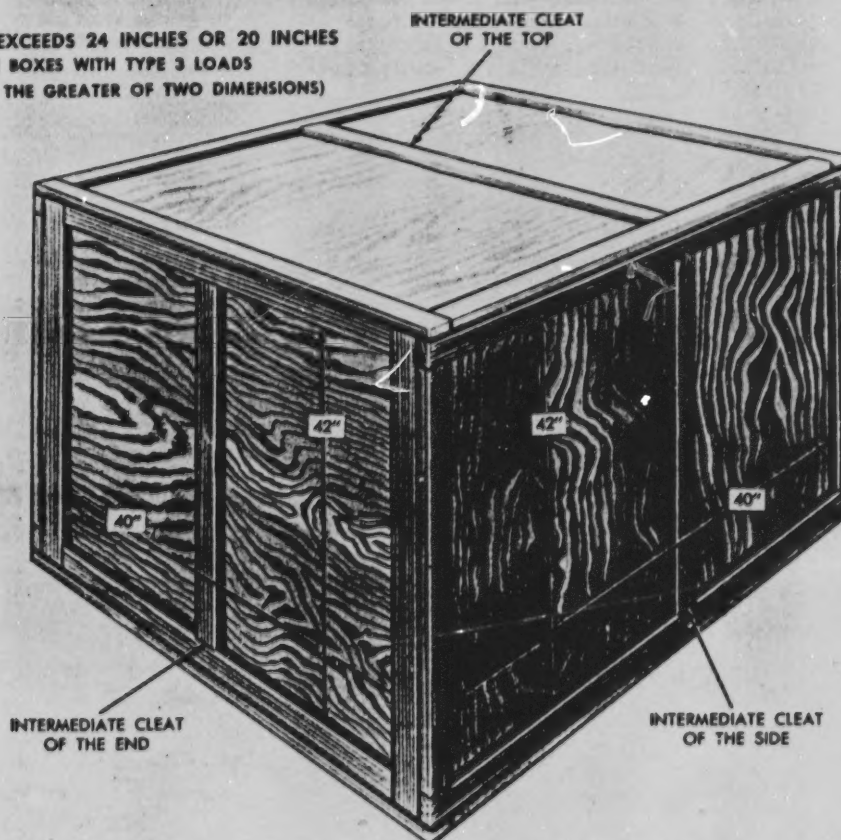
(f) Fasten strapping to the cleats with staples spaced approximately 6 inches apart, and within 4 inches from the edge of the box over which the strap passes (except over bands on the bottom of the box and bands applied over filler cleats on the top). Staples shall be applied just prior to shipment where practicable.

(g) Alternately, each lengthwise and girthwise strap may be replaced by four corner straps each 8 inches long and secured to the box with

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UNFRAMED AREA EXCEEDS 24 INCHES OR 20 INCHES
FOR OVERSEAS TYPE BOXES WITH TYPE 3 LOADS
(PERPENDICULAR TO THE GREATER OF TWO DIMENSIONS)



BOX WITH APPROXIMATELY SAME DIMENSIONS
PERPENDICULAR TO FILLER EDGE CLEATS ON
THE ENDS, TOP, AND BOTTOM, AND TO THE
THROUGH EDGE CLEATS OF THE SIDES

NOTE: STRAP OVER THE INTERMEDIATE CLEATS ON THE SIDES, TOP, AND BOTTOM

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Figure 3-22. Spacing of intermediate cleats.

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Table 3-17. Oversea Type, Sizes and Spacing of Nails for Fastening Together Adjacent Cleated Panels

Cleats, thickness (Inch)	Maximum spacing of nails, all wood groups		Size of nails for wood groups ¹			
	Type 1 and 2 loads	Type 3 load	I	II	III	IV
	Inches	Inches	Penny	Penny	Penny	Penny
5/8	5	4	8	7	7	6
3/4	5	4	9	8	7	6
7/8	4	3	10	9	8	8

¹ If the nail protrudes through the last edge cleat or if it splits the cleat, then the next smaller size penny nail shall be used.

Table 3-18. Diameter of Round Wire Strapping

Weight of contents	Diameter of wire when different numbers of wire are used			
	2 wires		3 or more wires	
	100,000 pounds per square inch tensile strength	140,000 pounds per square inch tensile strength	100,000 pounds per square inch tensile strength	140,000 pounds per square inch tensile strength
Pounds	Inch	Inch	Inch	Inch
Up to 70, incl	0.0720 (15 gage)	0.0720 (15 gage)	0.0720 (15 gage)	0.0720 (15 gage)
71 to 125, incl	0.0800 (14 gage)	0.0720 (15 gage)	0.0800 (14 gage)	0.0720 (15 gage)
126 to 175, incl	0.0915 (13 gage)	0.0800 (14 gage)	0.0915 (13 gage)	0.0800 (14 gage)
176 to 250, incl	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)
251 to 400, incl			0.0915 (13 gage)	0.0915 (13 gage)
401 to 1,000, incl			0.1055 (12 gage)	0.0990 (12-1/2 gage)

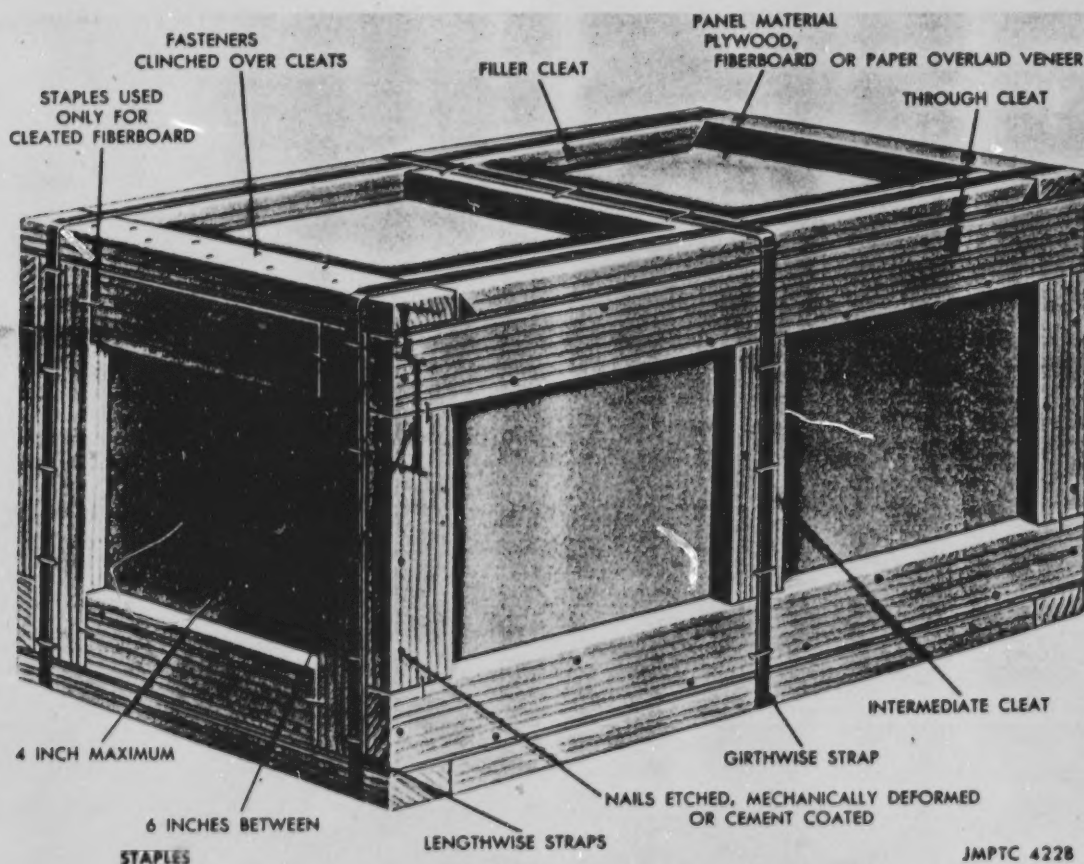


Figure 3-23. Strapping of cleated panel boxes.

three staples on each leg pneumatically driven through the strap into the cleat.

(2) *Styles A through K (domestic).*

(a) Strap domestic styles only when specified.

(b) Strap in accordance to the appendix to Specification PPP-B-601.

(c) Exercise care in strapping domestic styles so that the straps do not pass over voids between cleats and thus become susceptible to snagging.

(d) To eliminate strapping over a void, use filler cleats when applying two straps on Style D and G boxes.

(e) Corner straps may be used in lieu of lengthwise and girthwise straps. See paragraph 3-4g(1)(g) for details.

h. Dimensions. Dimensions shall be given in the sequence of length, width and depth of the inside measurements. The first two dimensions will be

Table 3-19. Size of Flat Metal Bands

Weights of contents	Dimension of flat metal bands when different numbers of bands are used	
	2 bands	3 or more bands
Pounds	Inch	Inch
Up to 70, incl	3/8 by 0.020	3/8 to 0.020
71 to 125, incl	3/8 by .020	3/8 by .020
126 to 175, incl	1/2 by .020	1/2 by .020
176 to 250, incl	5/8 by .020	5/8 by .020
251 to 400, incl		3/4 by .020
401 to 1000, incl		3/4 by .023

Table 3-20. Size of Type III, Twist-Tied Flat Metal Strapping

Weight of contents not exceeding	Dimensions when different numbers of bands are used	
	2 straps	3 or more straps
Pounds	Inch	Inch
70	0.140 by 0.031	0.138 by 0.025

Table 3-21. Requirements for Fiberboard for Class I Domestic Box (PPP-B-591)

Weight of contents of box		PPP-F-320 material requirements	
Exceeding	Not exceeding	Type CF (double-faced Class—domestic Grade	Type SF (solid-fiberboard) Class—domestic Grade
Pounds	Pounds		
0	75	200	200
75	150	275	275
150	225	300	300
225	300	350	350
300	400	400	375

Table 3-22. Requirements for Fiberboard for Class II Weather-Resistant Box (PPP-B-591)

Weight of contents of box		Style of box	Dimensional limitations, maximum			PPP-F-320 material requirements, type SF Grade
Not exceeding			Length	Width	Depth	
Pounds			Feet	Feet	Feet	
200		A or B	4	3	3	V3s or V4s

Table 3-23. Size of Cleats for Class I Domestic Box (PPP-B-591)

Style of box	Weight of contents of box		Minimum size of cleats		
	Exceeding	Not exceeding	Thickness		Width
			Groups I and II woods	Groups III and IV woods	All wood groups, inclusive
	Pounds	Pounds	Inch	Inch	Inches
C through K	0	75	11/16	5/8	1-1/2
C through K	75	150	3/4	11/16	1-11/16
A and B	0	75	5/8	9/16	1-1/2
A and B	75	150	11/16	5/8	1-3/4
A and B	150	300	3/4	11/16	1-3/4
A and B	300	400	1	13/16	1-3/4
A and Ab					

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the open face of the box. A tolerance of plus or minus $\frac{1}{8}$ inch is permitted in the dimensions.

3-5. Cleated Fiberboard Boxes (PPP-B-591)

These boxes are identical in styles and similar in construction to the cleated plywood boxes with the following exceptions:

a. Fiberboard is used in place of plywood as the panel material (tables 3-21 and 3-22).

b. Cleated fiberboard boxes handle only Type 1 and 2 loads. Styles A and B only are authorized for both domestic and overseas shipments. They are limited to a maximum weight of 400 pounds domestic and 200 pounds overseas, with a size limit of 4 feet $\times$ 3 feet $\times$ 3 feet.

c. Staples or corrugated fasteners are used to fasten the cleats at all butt joints. (See tables 3-23 and 3-24 for size of cleats.)

d. Panels may be glued to cleats on domestic boxes.

e. Panels may be made up of one or two pieces of fiberboard at the option of the contractor. The only acceptable joint is a butt joint. A joint cleat, of the same thickness and twice the width of the edge cleat, shall be placed over each butt joint.

f. Oversea boxes require intermediate cleats when the unsupported span exceeds 20 inches. Domestic boxes require intermediate cleats when the unsupported span exceeds 24 inches.

3-6. Cleated Paper Overlaid Veneer Boxes (PPP-B-576)

These boxes are identical in styles and similar in construction to the cleated plywood and cleated fiberboard boxes with the following exceptions:

a. Paper overlaid veneer, conforming to Specification PPP-V-205, is used in place of plywood as panel material.

b. Wood cleated paper overlaid veneer boxes take all three types of loads to a maximum weight of 400 pounds for domestic use (Class 1 boxes), and 350 pounds for oversea use (Class 2 boxes), in accordance with Specification PPP-B-576. Styles A and B only are authorized for both domestic and oversea shipments.

c. Tables 3-25 and 3-26 contain the requirements for the paper overlaid veneer panelboard and the cleats for Class 1 and 2 boxes, respectively, according to the weight of contents.

d. Skids are attached to the bottom of boxes having a gross weight of more than 200 pounds, or when the length and width dimensions are 48 inches by 24 inches or over and the gross weight is 100 pounds or over. The skids shall be a minimum of $2\frac{1}{2}$ inches high and $3\frac{1}{2}$ inches wide and may be fabricated from more than one piece of lumber to make up the required height. The skids shall be set not less than $2\frac{1}{2}$ nor more than 4 inches in from each end. Filler cleats of the same thickness as the edge cleats and the same width as the skids

Table 3-24. Size of Cleats for Class II Weather-Resistant Box (PPP-B-591)

Style of box	Weight of contents of box		Minimum size of cleats, for all wood groups	
	Exceeding	No exceeding	Thickness	Width
	Pounds	Pounds	Inch	Inches
A or B	0	200	$\frac{3}{4}$	$1\frac{3}{4}$

Table 3-25. Class 1 Boxes: Requirements for Paper Overlaid Veneer Panelboard and Cleats

Weight of contents		Size of cleats		Paper overlaid veneer panelboard	
				Types 1 and 2 loads	Type 3 loads
Exceeding	Not exceeding	Minimum width	Minimum thickness	Minimum thickness	Minimum thickness
Pounds	Pounds	Inches	Inch	Inch	Inch
0	75	$1\frac{3}{8}$	$\frac{5}{8}$	0.070	0.090
75	150	$1\frac{3}{4}$	$\frac{5}{8}$	.115	.140
150	225	$1\frac{3}{4}$	$\frac{3}{4}$	.115	.140
225	300	$1\frac{3}{4}$	$\frac{3}{4}$	.170	.195
300	400	$1\frac{3}{4}$	$1\frac{3}{16}$	.225	—

Table 3-26. Class 2 Boxes: Requirements for Paper Overlaid Veneer Panelboard and Cleats

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Weight of contents		Size of cleats		Paper overlaid veneer panelboard	
				Types 1 and 2 loads	Types 3 loads
Exceeding	Not exceeding	Minimum width	Minimum thickness	Minimum thickness	Minimum thickness
Pounds	Pounds	Inches	Inch	Inch	Inch
0	100	1-3/4	5/8	0.070	0.120
100	250	1-3/4	3/4	1.40	.180
250	350	1-3/4	.225	—	—

should be placed between the skids and the bottom panel of the box.

3-7. Wood Cleated, Skidded, Load Bearing Base Boxes (MIL-B-26195)

These boxes may be used for the shipment of items which can be secured to a load bearing base. The sides, tops, and ends are of cleated panel construction. Panels may be plywood, fiberboard or paper overlaid veneer and comply with the applicable requirements of Specifications PPP-B-601, PPP-B-591, and PPP-B-576, respectively. Styles A (standard box corner), B (3-way interlocking corner), and C (similar to Style J with intermediate cleats) are used for Type I, domestic, and Type II, oversea shipments. The bases are fabricated as Class 1, plywood base, and Class 2, lumber base (fig 3-24).

a. Intended Use. Boxes covered by Specification MIL-B-26195 are intended to be used for items which can be attached to a load bearing base. It is intended that the entire load be carried on the base. The superstructure (top, ends, and sides) provides only for superimposed loads and protection against the elements. It is not intended for the box to be lifted or moved other than by the base. The superstructure may be removed for air shipment.

b. Fabrication of Panels. When panels are fabricated locally, they are made according to information contained in paragraph 3-4a, with the following exceptions:

(1) When intermediate cleats are required on top panels, their lengths shall be equal to the width of the container. The longitudinal cleats of Style A and B boxes are applied as filler cleats. Cleat arrangement on top panels is illustrated in figure 3-25.

(2) When joists are required for the superstructure to hold superimposed loads, they are selected in accordance with table 3-27.

(3) Joist supports are required to be placed beneath each joist (fig 3-26). The vertical and lateral supports shall comply with the material requirements for the cleat stock, except that the

thickness shall not be less than one inch thick for container loads greater than 1,000 pounds. The vertical joist supports shall be nailed to the side panels with nails long enough to pass through the support, the panel, and the intermediate cleat on the side, with a clinch of 1/8-inch for Group II, III, and IV woods and 1/4-inch clinch for Group I woods. Lateral movements of the joists are prevented by blocks cut from cleat stock.

c. Fabrication of Base Components (fig 3-24).

(1) *Skids.* Skids will be free of defects and made of Group II, III, or IV lumber. The cross section and length of skids are chosen from table 3-28, based upon weight of contents and load conditions, as illustrated in figure 3-27. For boxes whose outside width exceeds 36 inches, a third skid conforming to table 3-28 is added. The third skid is placed equidistant between the outer skids. At the ends of each skid, the lower half is beveled approximately 45 degrees.

Table 3-27. Selection of Joists for Wood Cleated, Skidded, Load Bearing Base Boxes (Joists spaced 24 inches—center to center)

Joist size (Inches, nominal)	Outside width of box (inches)
None required	0-16
1 x 2	17-24
1 x 4	25-36
2 x 4	37-60

(2) *Load bearing members.* Load bearing members will be free of defects which could materially weaken them. They are selected in accordance with table 3-29. The cross section of load bearing members for a particular load is determined either by assuming a total width of such load bearing members and determining the thickness necessary, or by assuming a thickness and determining a total width of load bearing members.

(3) *Lumber flooring.* Lumber flooring will be a minimum of 1-inch thick, and not less than 4 inches wide. Lumber is laid at right angles to the skids. The boards are separated one-eighth to one-fourth of an inch to allow for swelling and drain-

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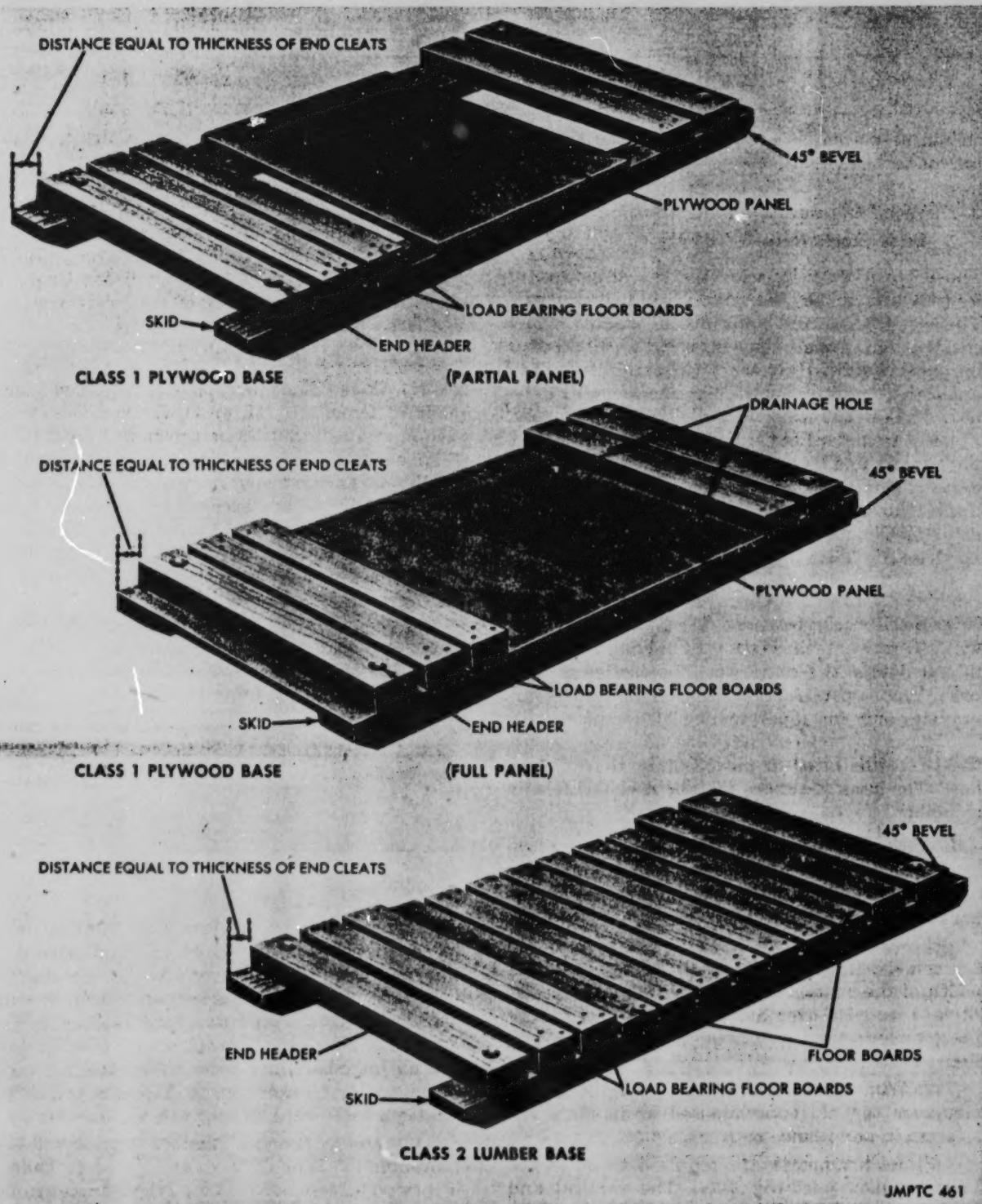


Figure 3-24. Classes 1 and 2 bases for wood cleated, skidded, load bearing base boxes.

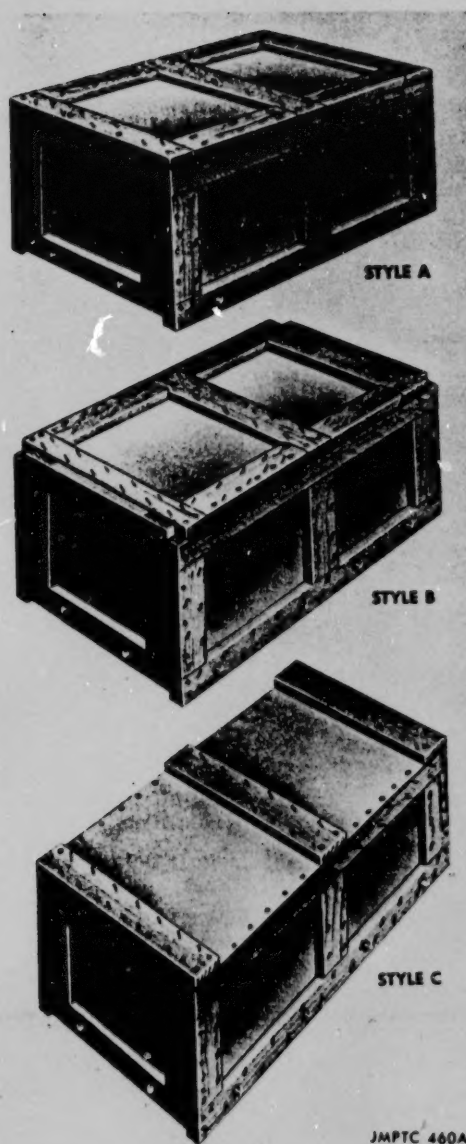


Figure 3-25. Styles A, B, and C cleat arrangement for wood cleated, skidded, load bearing base boxes.

age. The board ends are placed flush with the outer edge of the skids.

(4) *Plywood flooring.* Unless otherwise specified, plywood used for Type I boxes shall conform to PS 51, Type III Grade 3-4, PSI, Standard interior with exterior glue. The minimum thickness shall be $\frac{3}{8}$ inch. See table 3-13. It may be the full length and width of the base, or it may be a centrally located square piece with the length equal to the width. When a full piece of plywood is used, a drainage hole one-half inch in diameter is placed in each corner of the base. Additional

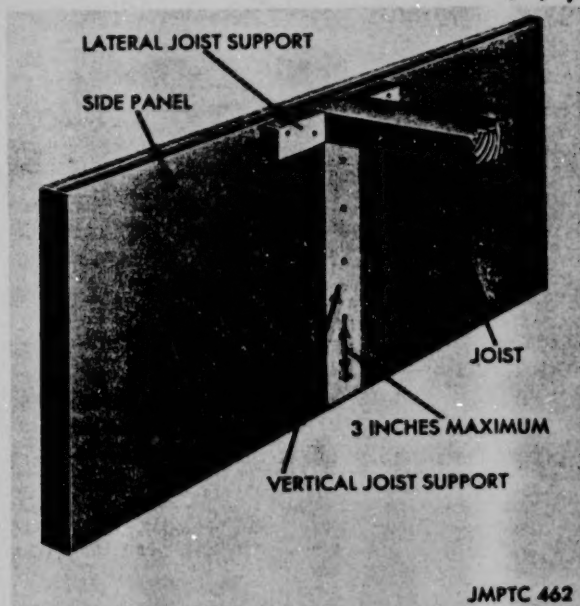


Figure 3-28. Attachment of joist supports for wood cleated, skidded, load bearing base boxes.

drainage holes are placed every three feet along the side of the base. When load bearing floorboards are placed over plywood panels, at least one drainage hole is placed on each side of the base between the load bearing floorboards.

(5) *End headers.* End headers are placed at the ends of the box. Headers are nominal 2×4 inches.

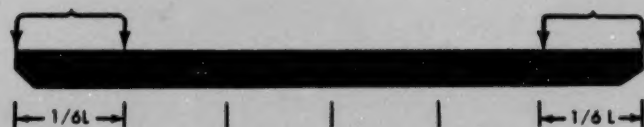
(6) *Rubbing strips.* When specified, rubbing strips shall be applied under each skid to facilitate fork lift handling. Rubbing strips shall be fabricated from one piece of 1-inch lumber and one piece of 2-inch lumber or from one piece of 3-inch lumber. Either combination will provide a nominal 3-inch clearance for forklift entry.

d. *Assembly of the Base.* Depending upon the weight of the item, load condition, size and length of skids, and whether it is a Class 1 or Class 2 base, the base parts are cut to size for fabrication.

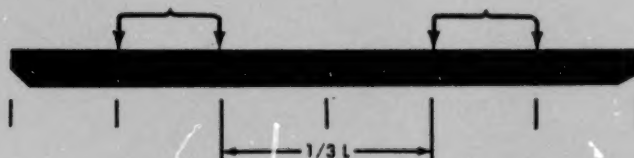
(1) The nailing of plywood and lumber flooring to the skids is illustrated in figure 3-24.

(2) Load bearing floor members over 2 inches thick and up to 4 inches in width are bolted to the skids with one carriage bolt at each end. Two carriage bolts are used at each end of load bearing floor members when they exceed two inches in thickness and 4 inches in width. The load bearing floor members are fastened to skids with $\frac{1}{2}$ -inch carriage bolts. Load bearing members less than 2 inches in thickness are nailed to the skids. Nails

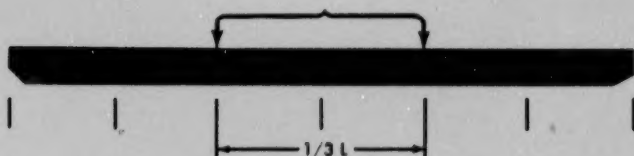
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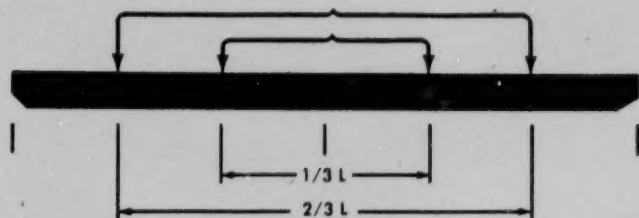
LOAD CONDITION A
LOAD BEARING POINTS ON OUTER ONE-SIXTHS OF SKID LENGTH



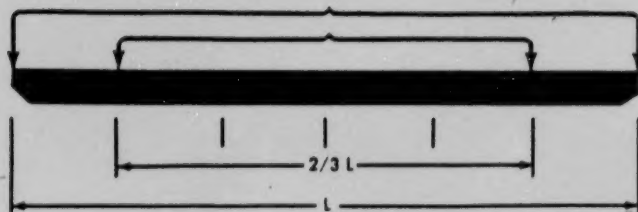
LOAD CONDITION B
LOAD BEARING POINTS OUTSIDE OF CENTRAL ONE-THIRD OF SKID LENGTH BUT NOT IN OUTER ONE-SIXTHS OF SKID LENGTH



LOAD CONDITION C
LOAD BEARING POINTS WITHIN CENTRAL ONE-THIRD OF SKID LENGTH OR
LOAD EVENLY DISTRIBUTED WITHIN CENTRAL ONE-THIRD OF SKID LENGTH



LOAD CONDITION D
LOAD EVENLY DISTRIBUTED OVER MORE THAN CENTRAL ONE-THIRD OF SKID LENGTH BUT NOT OVER MORE THAN CENTRAL TWO-THIRDS OF SKID LENGTH



LOAD CONDITION E
LOAD EVENLY DISTRIBUTED OVER MORE
THAN CENTRAL TWO-THIRDS OF SKID LENGTH

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Figure 3-27. Load distribution of skids.

Table 3-28. Nominal Sizes and Maximum Lengths of Skids for Wood Cleated, Skidded, Load Bearing Base Boxes

Weight of Contents (Pounds)	Load Condition <u>1</u> /	Nominal Sizes					
		2 x 4	2 x 6	2 x 8	4 x 4	4 x 6	6 x 6
Maximum Length of Skid (Feet)							
0 - 100	A	16	—	—	—	—	—
	B	16	—	—	—	—	—
	C	16	—	—	—	—	—
	D	16	—	—	—	—	—
	E	16	—	—	—	—	—
101 - 200	A	16	—	—	—	—	—
	B	16	—	—	—	—	—
	C	16	—	—	—	—	—
	D	16	—	—	—	—	—
	E	16	—	—	—	—	—
201 - 400	A	11	13	16	—	—	—
	B	13	16	16	—	—	—
	C	8	12	16	—	—	—
	D	10	13	16	—	—	—
	E	13	16	16	—	—	—
401 - 600	A	8	11	14	16	—	—
	B	9	14	16	16	—	—
	C	5	8	11	16	—	—
	D	7	10	14	16	—	—
	E	9	14	16	16	—	—
601 - 800	A	7	9	11	16	—	—
	B	7	10	14	16	—	—
	C	4	6	8	16	—	—
	D	5	8	10	16	—	—
	E	7	10	14	16	—	—
801 - 1000	A	6	8	10	16	—	—
	B	5	8	11	16	—	—
	C	3	5	7	16	—	—
	D	4	6	8	16	—	—
	E	5	8	11	16	—	—
1001 - 1200	A	6	7	8	16	—	—
	B	4	7	9	16	—	—
	C	3	4	5	13	16	—
	D	3	5	7	16	—	—
	E	4	7	9	16	—	—

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Table 3-28. Nominal Sizes and Maximum Lengths of Skids for Wood Cleated, Skidded,
Load Bearing Base Boxes—Continued

Weight of Contents (Pounds)	Load Condition ^{1/}	Nominal Sizes Maximum Length of Skid (Feet)					
		2 x 4	2 x 6	2 x 8	4 x 4	4 x 6	6 x 6
1201 - 1400	A	5	7	8	14	16	
	B	5	6	8	16		
	C	0	4	5	11	16	
	D	3	4	6	14	16	
	E	5	6	8	16		
1401 - 1600	A	5	6	7	13	16	
	B	3	5	7	16		
	C	0	3	4	18	15	16
	D	3	4	5	12	16	
	E	3	5	7	16		
1601 - 1800	A	5	6	7	12	16	
	B	3	5	6	15	16	
	C	0	3	4	9	14	16
	D	0	3	4	11	16	
	E	3	5	6	15	16	
1801 - 2000	A	4	5	6	11	15	16
	B	3	4	5	13	16	
	C	0	0	3	8	12	16
	D	0	3	4	10	15	16
	E	3	5	5	13	16	
2001 - 2200	A	4	5	6	10	14	16
	B	0	4	5	12	16	
	C	0	0	3	7	11	16
	D	0	3	4	9	14	16
	E	0	4	5	12	16	
2201 - 2400	A	4	5	6	10	13	16
	B	0	3	4	11	16	16
	C	0	0	3	7	10	16
	D	0	0	3	8	13	16
	E	0	3	4	11	16	
2401 - 2500	A	4	5	6	9	13	16
	B	0	3	4	10	16	
	C	0	0	3	6	10	16
	D	0	0	3	8	12	16
	E	0	3	4	10	16	

^{1/} The load condition is determined by the manner in which the load is applied to the skids (fig. 3-27).

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Table 3-29. Allowable Load Per Inch of Floorboard Width—
In Pounds (Group I and II Woods)¹ for Wood Cleats,²
Skidded, Load Bearing Base Boxes

Length between outside skids Inches	Nominal 1 inch thick boards	Nominal 2 inch thick boards	Nominal 3 inch thick boards
12	38	176	459
18	28	118	306
24	19	88	230
30	15	70	183
36	13	58	154
42	11	52	131
48	10	44	115
54	9	39	102
60	7	35	92

¹ If group III and IV woods are used, the above allowable loads may be increased by 20 percent.

shall be as large as practicable without splitting the piece.

(3) The end headers are fastened to the skids with 1/2-inch carriage bolts.

e. Assembly of the Superstructure. The assembly of the cleated plywood, cleated fiberboard, and cleated paper overlaid veneer panels into the superstructure shall comply with the applicable requirements of the specifications already described. When joists are required, they are placed as explained in *b* above.

f. Assembly of the Superstructure to the Base. The end and side panels are assembled to the base with lag bolts (sometimes referred to as "lag screws"). One 3-inch lag bolt, three-eighths inch in diameter, is placed through the lower longitudinal cleat of the side panel and into the skid, at a distance not less than 3 inches from the end of the cleat. The distance between additional lag bolts shall not exceed 12 inches. In attaching the end to the header, one lag bolt is placed through the lower filler cleat and into the end header, at a distance not less than 2 inches, nor more than 3 inches from the end of the filler cleat. A minimum of two lag bolts are required through each end filler cleat.

CAUTION

Lag bolts shall not be driven with a hammer except to start them. They shall be turned in their holes the full distance. If the threads become stripped in the wood, the lag bolt is to be removed and inserted in a new hole near the old position. A washer is placed under the head of each lag bolt. Countersinking of lag bolts is not permitted.

3-8. Wirebound Wood Boxes (PPP-B-585)

A wirebound wood box is a resilient engineered structure deriving both strength and economy from the substitution of steel wires for a considerable portion of wood. The sides, top, and bottom of this container are stapled to several binding wires and are fastened to a framework of cleats at each end by staples driven astride the end binding wires. The ends are nailed, stapled, or wired to the cleat framework to form the container.

a. Description of Box Components (fig 3-28).

(1) *Blank.* A blank is the assembled parts of a wirebound wood box. The wood faceboards of the box are held together by wires which are stapled to them. Blanks are "set up" to form a box.

(2) *Cleats.* Cleats form the framework to which the ends of the faceboards or slats are fastened. They are made with mitered or mortised and tenoned ends (tongued-and-grooved). Intermediate rows of cleats may be required to reinforce unsupported spans.

(3) *Faceboards.* Faceboards are the thin boards that form the six faces of the box. They are made of veneer, resawn lumber, plywood, or paperoverlaid veneer. Their chief function is to hold the contents of the box in place.

(4) *Binding wires.* They hold the faces of the box together and carry most of the weight in the box.

(5) *Staples.* They hold the faceboards and cleats to the binding wires.

(6) *Ends.* The ends may be either plain, lined, or battened, according to the type of material used, the weight of contents, and the type of load. Only ends made from plywood are plain.

(a) *Battens.* They are pieces of wood used on the ends of wirebound wood boxes to reinforce the ends, to reinforce the cleats, and to increase the strength of the box so that it may carry heavy stacking loads.

(b) *Liners.* They are thinner pieces of boards stapled to the ends in order to tie all parts together and to strengthen the fastening section. The grain of the liner is placed at right angles to the grain of the end faceboard. They are stapled to either the outside or inside face of the ends. Liners for Styles 1 and 2 boxes are always vertical; liners for Style 3 boxes are always horizontal.

b. Classes.

(1) *Class 1 domestic.* For domestic shipments not involving sea transportation, but subject to storage, rehandling, or reshipment to domestic destinations. Weight limitation is 500 pounds.

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(2) *Class 2 normal oversea.* For off-shore and oversea shipments contemplating projected storage and commercial-type handling. Weight limitation is 400 pounds.

(3) *Class 3 military oversea.* For oversea shipments and handling in military supply systems, subject to repeated rehandling and unprotected storage, and which may also be subjected to extreme climatic conditions. Weight limitation is 300 pounds.

c. Styles of Boxes. Three styles of wirebound wood boxes are used for domestic and oversea shipments. These styles differ primarily in the manner of closure of the binding wires. Each style can be easily recognized in figure 3-29. Style 1 has a twisted wire closure, Style 2 has a looped wire closure, and Style 3 has a looped wire closure and has the ends reinforced with wire instead of battens. Unless end battens are used, the Style 3 box is not recommended for Type 3 (difficult) loads.

d. Ordering Data. Wirebound wood boxes are engineered and manufactured commercially and are not made locally by military activities. Procurement documents should include the specification number (PPP-B-585); the inside length, width, and depth to the nearest one-sixteenth of an inch; the style of box; the class of box; the type

of load; the weight, quantity, and marking of contents. If blocking or bracing is required, it is suggested that a drawing or a sample of the item be furnished to the box manufacturer.

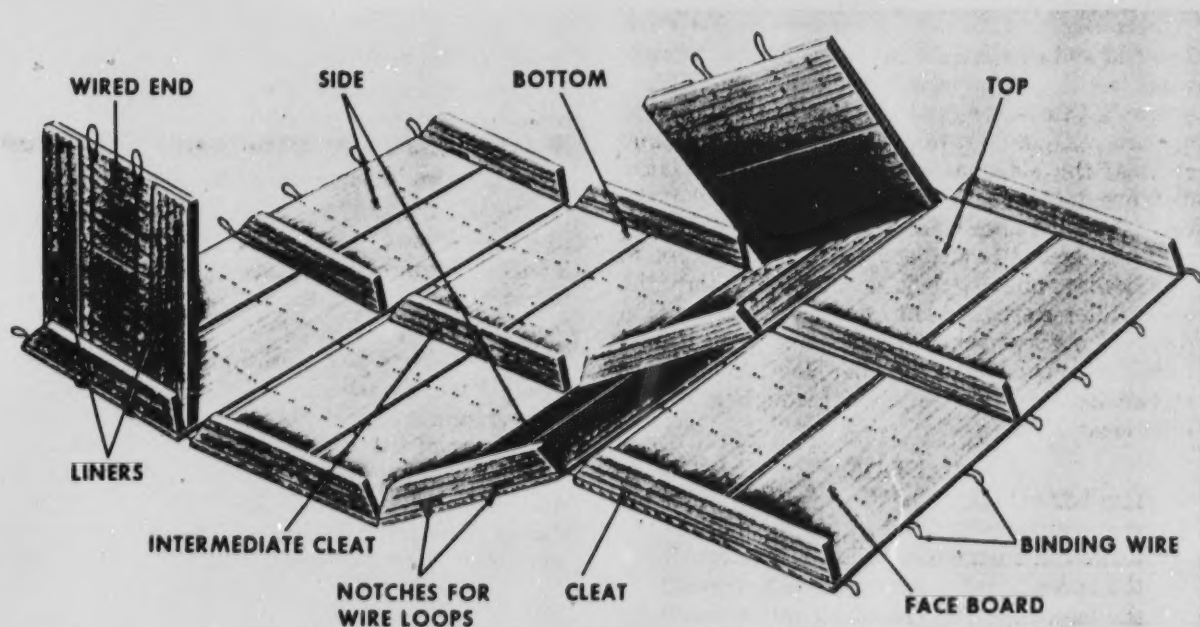
e. Container Manufacturer's Identification. Unless otherwise specified, each box is imprinted with the following information, which is limited to 15 square inches and placed in a lower corner of one side panel:

- (1) Federal Specification PPP-B-585.
- (2) Box manufacturer's name.
- (3) Plant location.
- (4) Maximum weight of contents . . . pounds.
- (5) Class . . . box. For type . . . load. Style . . .

Box.

f. Box Usage. Each box is manufactured to do a specific job. When used for the proper maximum weight of contents, type of load, and class of use, it will afford adequate protection to the item being shipped. It is important that the container manufacturer's identification be utilized prior to packing. The following points must be considered:

- (1) In using the boxes, care should be exercised to select the box designed for the type of load to be shipped. A Type 2 load will not be packed in a box designed to carry a Type 1 load,



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Figure 3-28. Components of wirebound wood boxes.

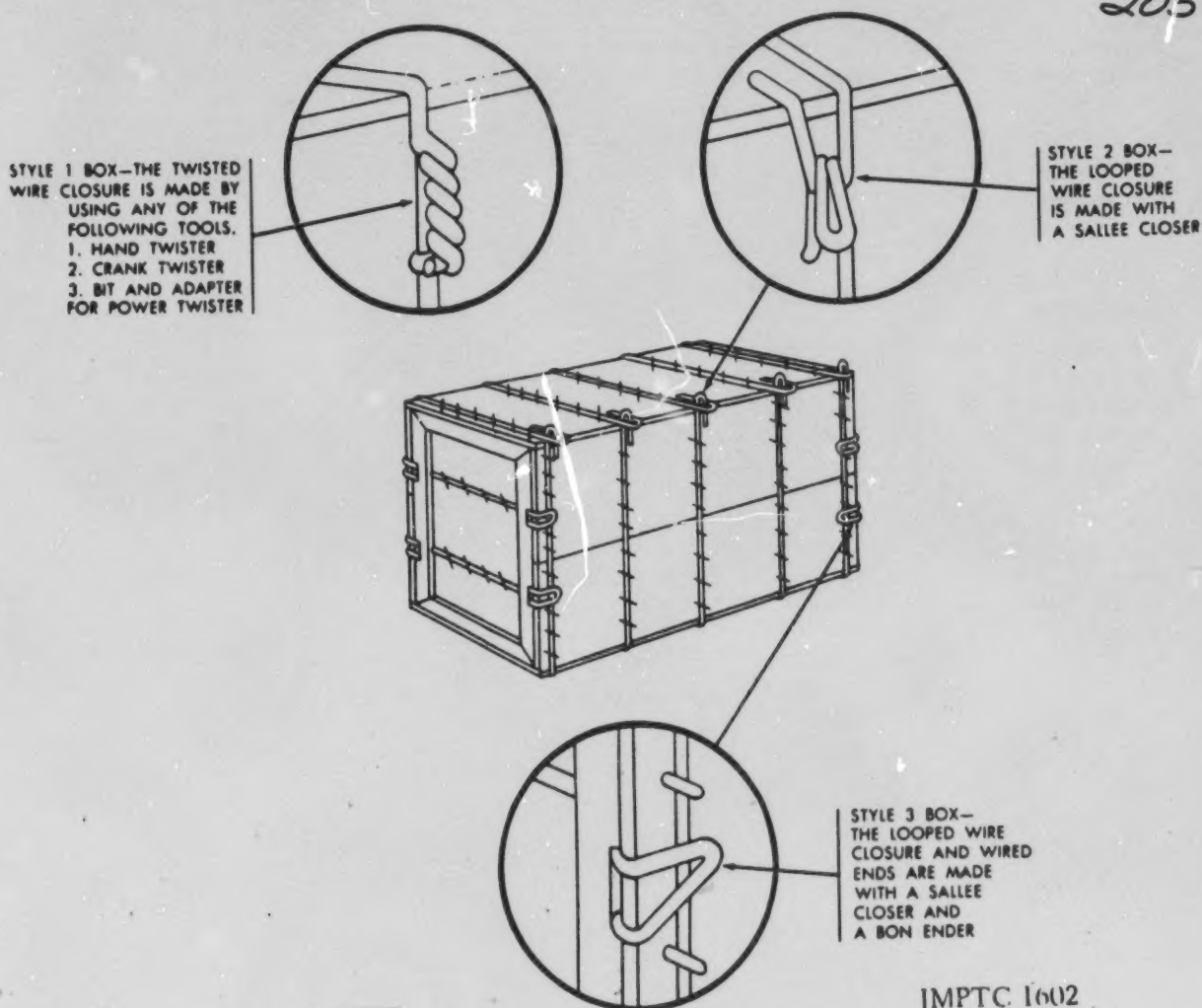


Figure 3-29. Styles of wirebound wood boxes.

and a Type 3 load will not be packed in a box designed to carry either a Type 1 or a Type 2 load.

(2) For Type 1 and 2 loads, the inside dimensions of the box will be sufficiently exact so that the contents fit snugly into the box and give support to all its faces.

(3) For Type 3 loads, other than bulk loads, the contents will be firmly bolted, blocked, braced, or otherwise anchored to the frame of the box in such a manner that shifting of the contents will not occur during handling of the shipment.

g. Economy Factors.

(1) Generally, a wirebound wood box contains approximately one-half as much lumber as a nailed wood box of the same size which carries the same amount of contents. Wirebound wood boxes are usually available at a lower price than many

other shipping containers of more rigid construction.

(2) Style 3 boxes are resilient on all six faces. Items requiring this characteristic in the box can use a Style 3.

(3) Style 3 boxes are the most economical of the styles. The original cost of the box is less than that of the other styles. The savings of time in setting up the boxes is advantageous.

(4) Since the amount of lumber in a wirebound wood box is greatly reduced, compared to other types of wood containers, the tare weight is lower. Accordingly, the freight charges on a given size shipment are correspondingly lower.

(5) There is a saving in labor operations due to the simplicity of assembly and the ease of closure.

(6) Styles 2 and 3 boxes can be opened and

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reclosed at intermediate stages of distribution much easier than other kinds of containers.

(7) Wirebound boxes may be recoopered.

h. Setting up the Boxes. Boxes arrive from the manufacturer in a knockdown condition and are stored knockdown until the time of use. Each box is then set up prior to loading of shipment. The method of setting up depends upon the style of the box.

(1) *Setting up of Styles 1 and 2 (fig 3-30).*

(a) Lift the sides of the blank slightly before folding. Fold the box by raising the sides at right angles to the bottom.

(b) Fasten the ends to the side cleats using a steel nailing table or an end stapling machine.

1. Ends are fastened to side cleats by either staples or cement-coated and chemically-etched nails. Unless otherwise specified, staples for Class 3 use boxes are galvanized.

2. The length of each fastening will be not less than the thickness of the end boards plus three-quarters the thickness of the cleats or battens.

3. The points of the fastenings will not protrude from the cleats or battens, but, if driven through, they must be clinched.

4. The average spacing of the fastenings will not exceed 2½ inches.

(c) Drive sevenpenny cement-coated or chemically-etched cooler or sinker nails through side cleats into adjacent battens and through bottom cleat into intermediate batten. Boxes having both vertical and horizontal battens adjacent and parallel to cleats should be fastened by nailing through bottom faceboards and cleats into the battens only. The spacing of nails driven into adjacent battens will not exceed 5 inches.

(2) *Setting up of Style 3 (fig 3-31).*

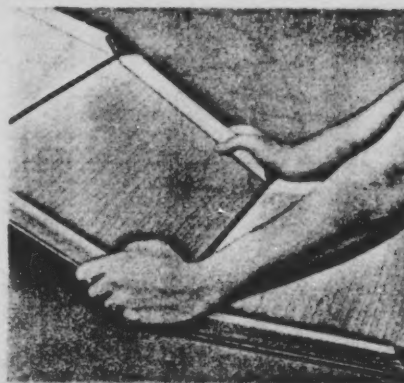
(a) Bend up looped end wires of ends using the hollow end of a bon ender.

(b) Lift sides of the blank slightly before folding and raise sides at right angles to bottom.

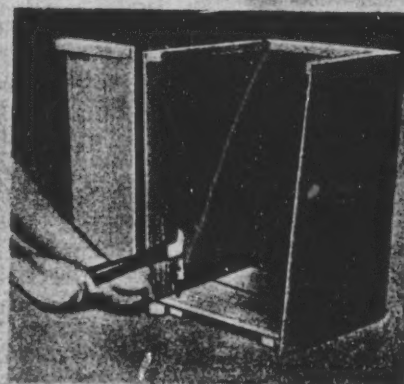
(c) Pass the bent end loops through notches in the cleats. Using the tapered end of the bond ender, bend back the looped wire over and around the binding wire of the side.

(d) When battens are used on the ends of Staple 3 boxes, the following rules apply:

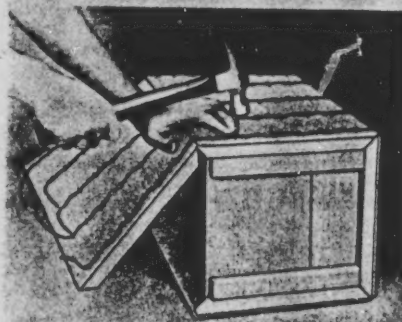
1. Battens adjacent to batten cleats are nailed by driving sevenpenny cement-coated or chemically-etched cooler or sinker nails through the bottom boards, through the cleat and into the



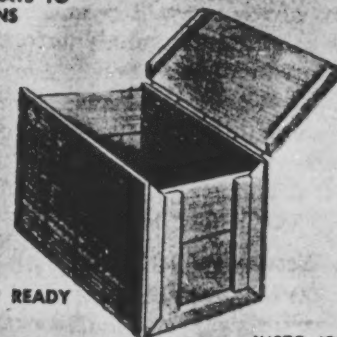
FORM BOX BY RAISING SIDES AT RIGHT ANGLES TO BOTTOM



NAILING ENDS TO SIDE CLEATS



NAILING SIDE CLEATS TO ADJACENT BATTENS



COMPLETED SET-UP READY FOR PACKING

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Figure 3-30. Setting up of styles 1 and 2, wirebound wood boxes.

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adjacent batten. Spacing of nails will not exceed 5 inches.

2. Intermediate battens are secured by driving one sevenpenny cement-coated or chemically-etched cooler and sinker nail through the board and cleat into the end of the intermediate batten.

i. *Strapping Requirements.* Where strapping is required, the top cleats shall be brought in contact with the side cleats and the strapping is applied before the wires at the closing edges are twisted or looped. This eliminates occasional slack which may develop when strapping is applied after closure is made. Strapping is placed as indicated in figure 3-32 according to Class 1, Class 2, or Class 3 box, based upon weight of contents. Round wire strapping cannot be smaller than 13-gauge. Flat strapping cannot be less than $\frac{3}{8} \times 0.020$ -inch.

j. *Closure of the Boxes.*

(1) *Closure of Style 1.* Style 1 boxes are closed by using special tools (fig 3-33). When intermediate battens are used on the ends of the box, one sevenpenny cement-coated or chemically-etched sinker or cooler nail is driven through the top board and cleat and into the end of each intermediate batten. This is done prior to making the closures of the binding wires.

(2) *Closure of Styles 2 and 3.* These styles are closed by using a Sallee closer. Perform the steps, as shown in figure 3-34.

(a) Insert the Sallee closer through the side loop and catch the top loop in the notch on the end of the tool.

(b) Raise the handle of the Sallee closer to slightly beyond a vertical position and push the top loop down against the side of the box.

(c) Complete closing by swinging the handle of the Sallee closer down as far as possible.

(d) Drive a nail through the top cleat into each intermediate batten. Do not nail into the ends of the battens that are adjacent to the cleats.

Note. The applicable tools for making closures are illustrated in figure 3-33 and 3-34. Correct tools are available from box manufacturer. Do not use screw drivers, pliers, etc., because an adequate closure cannot be made and their use is time-consuming and may be a safety hazard.

3-9. Pallets (General)

a. *Description.* A pallet is a portable platform on which material is placed to facilitate handling and transportation. This platform is generally a two-deck structure which permits mechanical han-

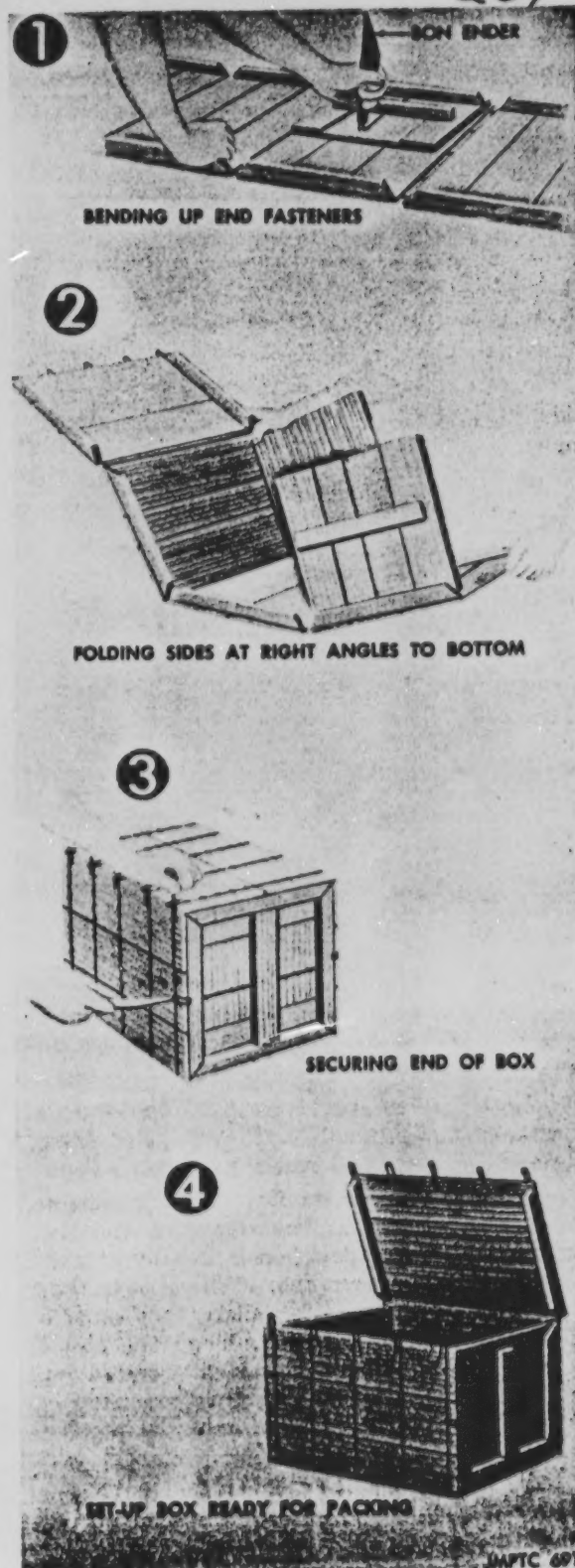


Figure 3-31. Setting up of style 3 wirebound wood box.

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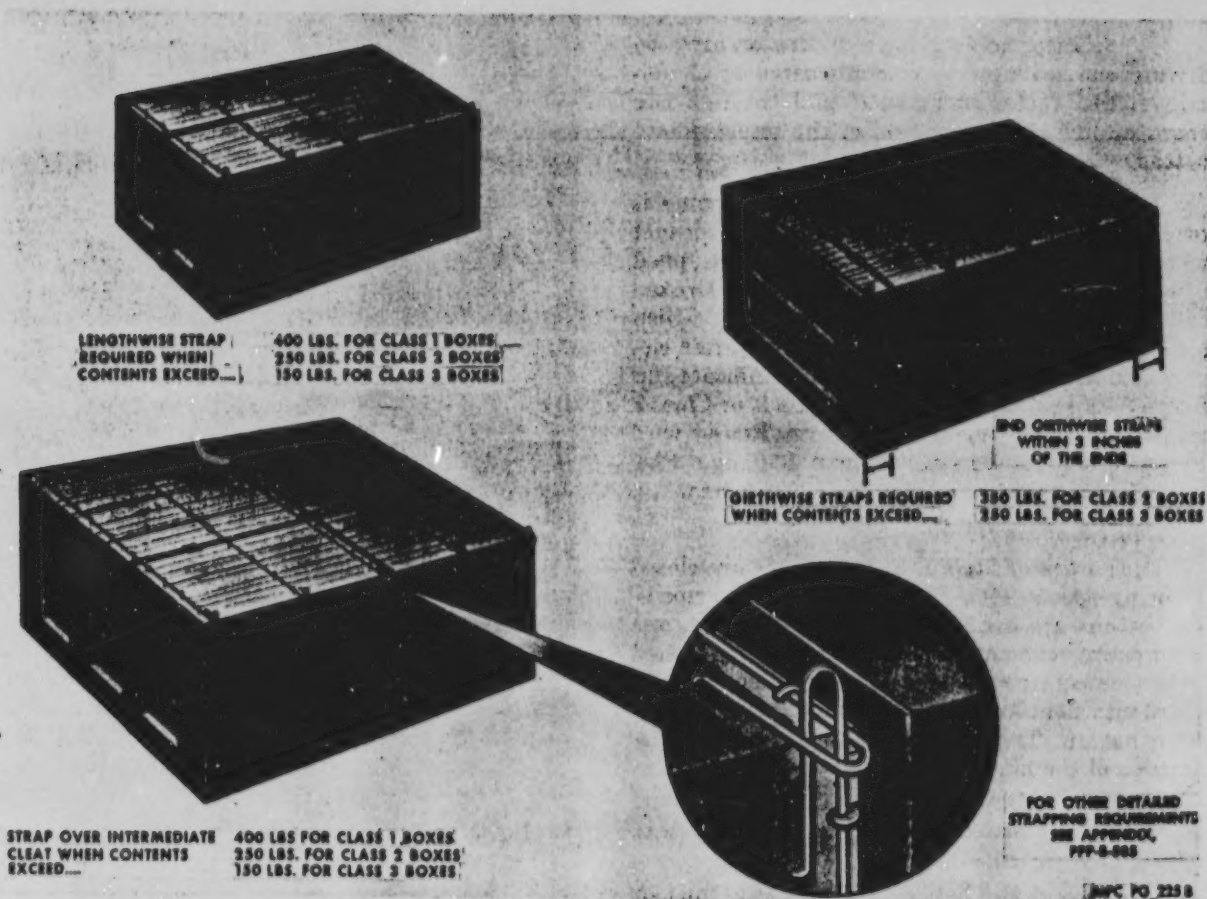


Figure 3-32. Strapping of wirebound wood boxes.

dling and tying of unit loads of supplies and equipment.

b. *Types of Pallets.* Pallets are classified as expendable and permanent. They are also classed as general purpose and special purpose.

(1) *Expendable pallets.* Expendable pallets are designed generally for one shipment and then discarded. Their construction is usually of wood, fiberboard, or a combination of the two. In order to be effective as one-trip pallets, they must be lightweight and low in cost. When the cost of using them is equalled or exceeded by the savings realized during a single trip, they are truly expendable pallets. Examples of expendable pallets are illustrated in figure 3-35.

(2) *Permanent pallets.* Permanent pallets are termed as general purpose and special purpose pallets.

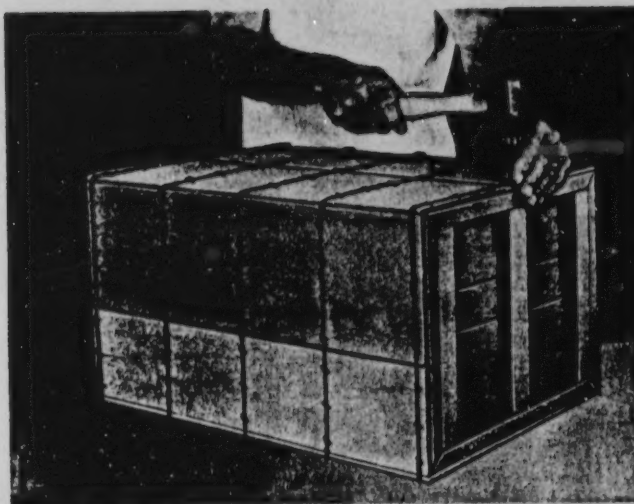
(3) *General purpose pallets.* The general purpose pallets are constructed of hard wood and are

normally 40 inches by 48 inches in size. They fit economically into railroad cars, motor vehicles, and trailers. Two general purpose pallets are the 4-way entry post pallet and the 4-way (partial) four-stringer pallet. (fig 3-36).

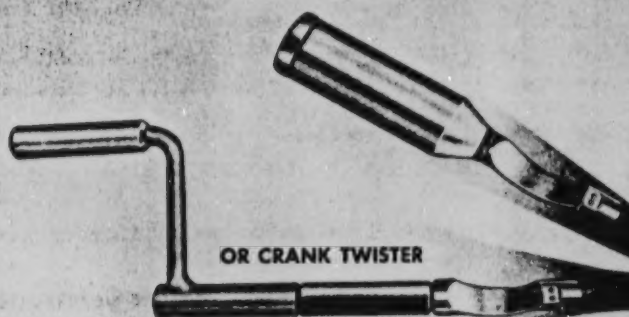
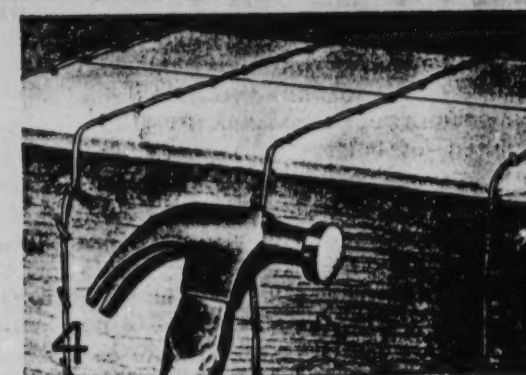
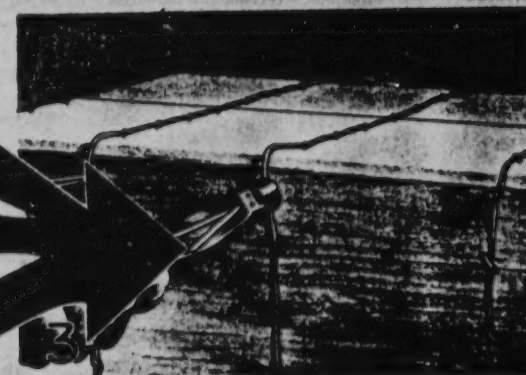
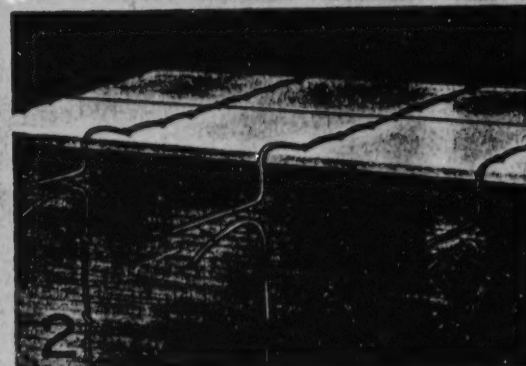
(4) *Special purpose pallets.* Pallets made of metal, which are suitable for certain heavy duty usage, are special purpose pallets. They are more rugged and will stand more abuse than wood pallets. There are no fasteners to work loose and cause damage to flexible containers and their contents. Pallets made of aluminum have been developed that are light in weight. The initial cost of metal pallets is high in comparison to pallets made of wood.

3-10. Four-Way Post Construction Pallets (MIL-P-15011)

These pallets are available in two types: Type I

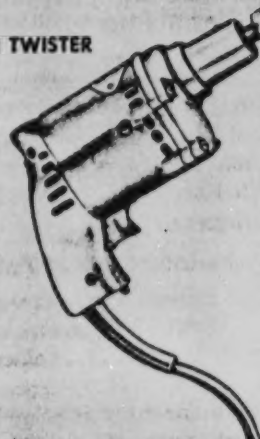


HAND TWISTER



OR CRANK TWISTER

OR POWER TWISTER



JMPTC 147

Figure 3-33. Closing of style 1 wirebound wood box.

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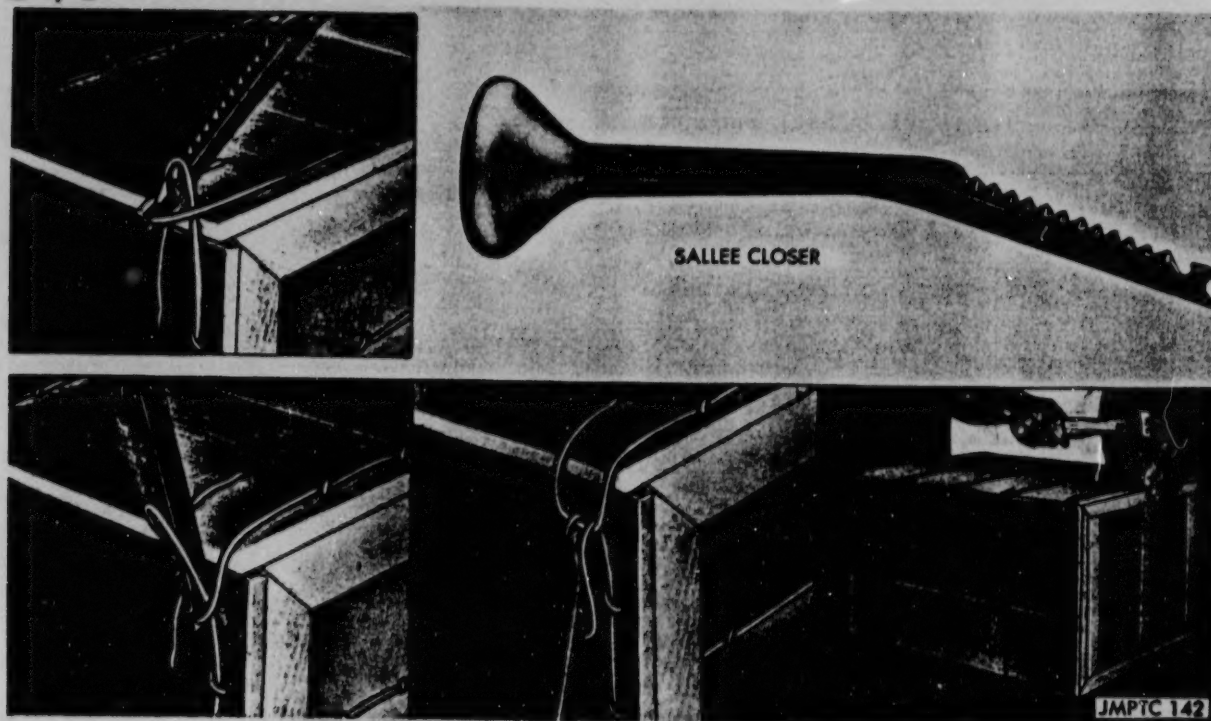


Figure 3-34. Closing of style 2 and 3 wirebound wood boxes.

(assembled) and Type II (unassembled). Each type is available in two classes: Class 1 (seasoned lumber, 22 percent maximum average moisture content); class 2 (unseasoned lumber, unspecified moisture content). There are three styles. Style 1 is the general storage pallet and is of the standard 40 inch by 48 inch size, and unless otherwise specified, is constructed of high density wood. Style 1A pallets are constructed the same as Style 1 pallets except that the size is 35 inches long by 45½ inches wide. The smaller, Style A1 pallets are designed for better utilization in intermodal transporters. The third style, Style 2, is a lightweight, air cargo pallet, 40" × 48" in size. It is constructed of the low or medium density woods with thickness less than that for Styles 1 and 1A. These pallets provide full 4-way entry to materials handling equipment. As indicated in figure 3-36 nine post are placed on the bottom boards with drive-screw nails conforming to type II, style 18, of FF-N-105. Stringers extending the length (40 inches, Styles 1 and 2 and 35 inches for Style 1A) of the pallet are fastened to each row of posts. The deck boards are nailed through the stringers and into the posts.

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3-11. Four-Way (partial) Stringer Construction Pallets (NN-P-71)

Two-way and four-way stringer pallets are available in several types and may be assembled or unassembled. Each type is available in various sizes. They are used wherever two-way or partial four-way entry is required by conventional materials handling equipment. As indicated in figure 3-40, four stringers made from 2 × 4-inch lumber are nailed or bolted at right angles to the bottom deck boards. The stringers are cut out to enable fork lift entry. The top deck boards are nailed to the stringers.

3-12. Maintenance of Pallets

Wooden pallets are susceptible to damage and must be kept in constant repair. Broken or split deck boards must be replaced when their holding power is impaired. Fastenings that work loose should be carefully repaired. When nails must be replaced, snip off nail heads and drive into stringer or block. Make sure that new nails do not line up with previously occupied nail holes. It is recommended that a stack of repair parts be available for making all repairs.

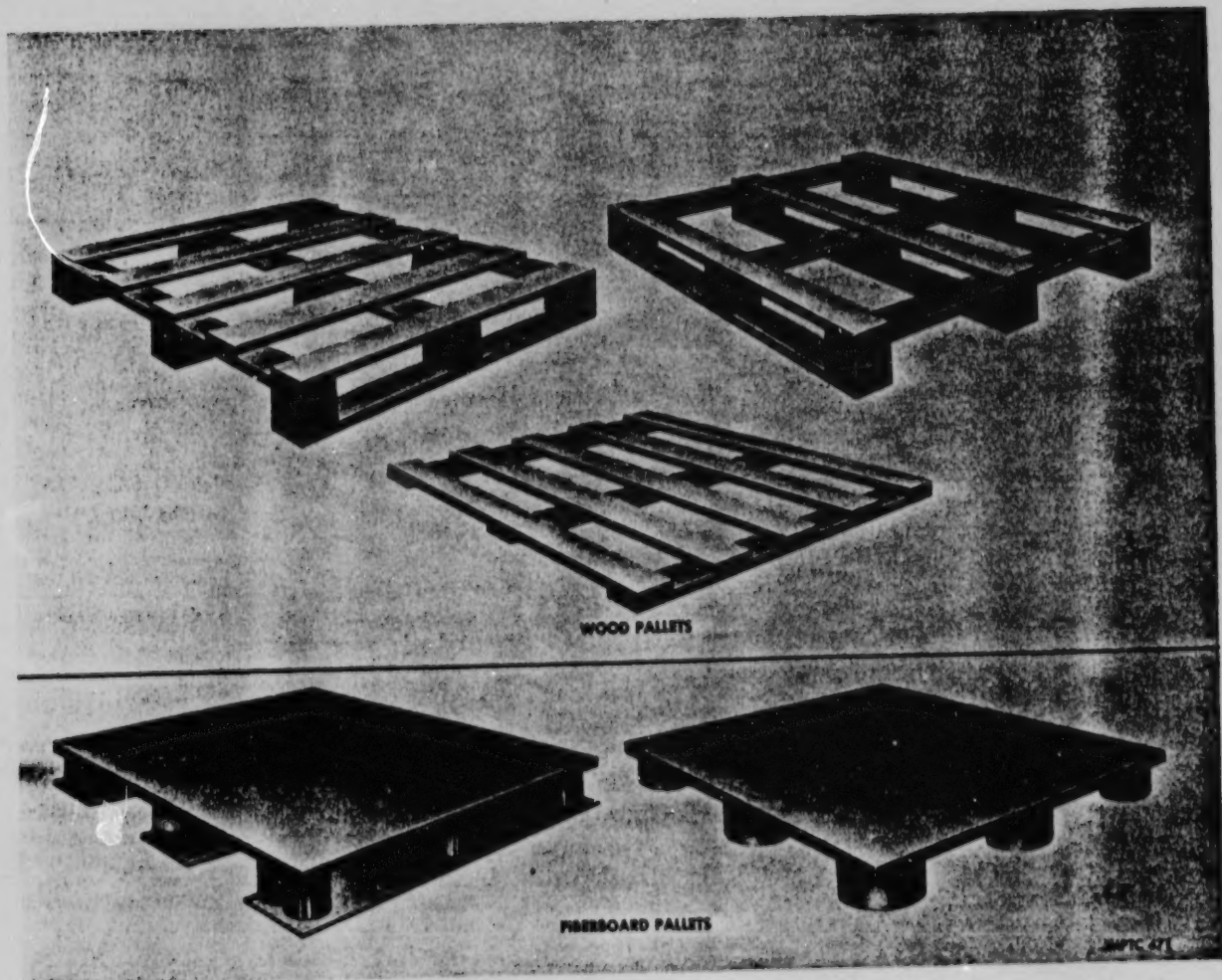


Figure 3-35. Examples of expendable pallets.

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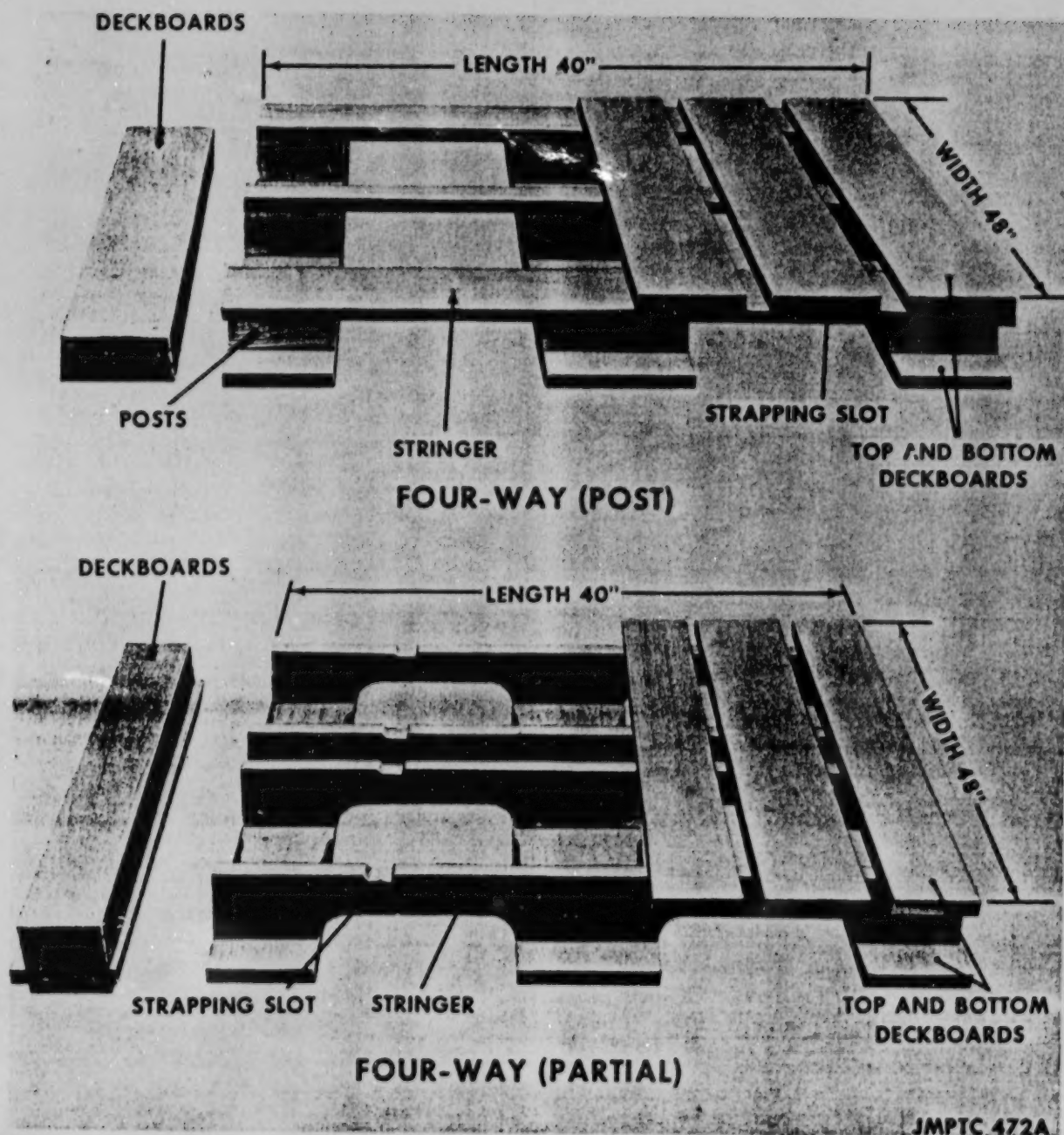


Figure 3-36. Construction of 4-way entry pallets.

CHAPTER 4

BAGS AND SACKS

4-1. Need for Bags and Sacks

While a considerable amount of the materiel furnished to the Military Services is shipped in fiberboard, metal, or wooden containers, there are many supplies which can be most economically shipped in bulk quantities in bags and sacks. Items such as food products, building materials, some chemicals and minerals are effectively shipped in bags and sacks. Bags and sacks possess the inherent advantages of having low tare weight ratio (that is, the ratio of the weight of the container to the weight of the contents); being flexible; providing ease in filling and handling; requiring a minimum storage space; and being constructed of low cost materials.

4-2. Bags Defined

A *bag* is a preformed container made of flexible material, generally closed on all sides except one which forms an opening that may or may not be sealed after filling. It may be made of a single ply or multiple plies of flexible material, or a combination of two or more materials such as paper, metal foil, cellulose, and plastic films and textiles, any of which may be coated, laminated, or treated to provide the properties required for packaging, storing, and distributing the commodity.

4-3. Sacks Defined

A *sack* often used as a synonym for a bag, generally refers to heavier duty or shipping bags. No exact line of separation can be drawn between what is referred to as heavy duty bag and a shipping sack. In this section, both bags and sacks are discussed and may be employed to handle the same weights and kinds of commodities. Usually, a container designed to carry over 50 pounds is considered a shipping sack.

4-4. Military Shipping Bags and Sacks

For shipping military supplies, there are five flexible containers that are approved for use by the Armed Forces. These containers are: cotton mail-

ing bags (PPP-B-20); cushioned paper shipping sacks (PPP-S-30); burlap, cotton, and waterproof textile shipping bags (PPP-B-35); paper shipping sacks (UU-S-48); and (table 4-1).

4-5. Cotton Mailing Bags (PPP-B-20)

Cotton mailing bags (fig 4-1) are intended for packaging and mailing small miscellaneous items. They are of the "end-opening" type with a drawstring closure of 12-ply, hard-finished cotton twine, inserted through a hem in the open end. Alternatively, when specified, the drawstring may be hard-finished (polished) twine of not less than 3-ply construction with a breaking strength of 25-30 pounds. A paper tag, made of white cotton cloth-lined paper stock, with a hard finish, suitable for pen and ink addressing on the face side, is securely sewn into the bottom seam of the bag. Cotton mailing bags are tied and bundled in the sizes and quantities shown in table 4-2.

4-6. Cushioned Paper Shipping Sacks (PPP-S-30)

Cushioned paper shipping sacks are made of two sheets of kraft paper separated by an evenly distributed cushioning medium. They may be used for interior or exterior packing where insulation, water resistance, or light cushioning effect is required for items weighing not more than 10 pounds.

a. *Classification.* Cushioned paper sacks are supplied in four types: Type I cushioned sacks are made with a 60-pound outer liner and a 40-pound inner liner (24 × 36-500 minimum weight).

b. The cushioning material should be evenly distributed between the exterior and interior sheets of the sack at a thickness of between $\frac{1}{8}$ and $\frac{3}{16}$ inches. Type II sacks are fabricated from a 70 pound outer liner (24 × 36-500 basis weight) with closed cell plastic fiber cushioning material $\frac{3}{16}$ inch thick. Type III and IV sacks are fabricated from a 60 pound outer liner (24 × 36-500 basis weight). Type III incorporates an expanded polystyrene foam bead cushioning material evenly

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Table 4-1. Bags and Sacks Used in Military Packing

Specification No.	Title	Type, grade, class, style	Uses
PPP-B-20 ----	Bags, cotton, mailing -----	The grade known commercially as "first."	For packing and mailing of small miscellaneous items.
PPP-B-35 ----	Bags, textile, shipping, burlap, cotton and waterproof, laminated.	Type I—Standard burlap bag—number B-1 through B-16, based on ply construction. Type II—Standard cotton bag—28 bag construction C-21 to C-71, not listed consecutively. Type III—Laminated textile bags. Class 1—Paper-asphalt-textile. Bag numbers P1 to P9. Class 2—Paper-asphalt-paper-asphalt-textile. Bag numbers P10 to P18. Class 3—Paper-asphalt-textile-asphalt-paper. Bag numbers P20 to P28. Class 4—Paper-asphalt-paper-adhesive-textile. Bag numbers P30 to P38. Class 5—Paper-latex (or other laminant)—textile. Bag numbers P40 to P48. Class 6—Polyethylene-adhesive-paper-adhesive-textile. Bag numbers P50 to P58. Class 7—Other combination as specified by the procuring agency. Grade I—Cotton sheeting. Grade II—Cotton, Osnaburg. Grade III—Jute burlap. Type IV—Textile inner bags.¹ Style A—Sewn side and bottom seams (for Types I, II, or III). Style B—Cemented longitudinal seams sewn and taped bottoms (for Type III only).	For domestic or oversea shipment of supplies of a pulverized, powdered, granulated or crystalline condition, and of a hygroscopic or non-hygroscopic nature. The user will need to consult tables XI and XII of PPP-B-35 to determine the proper bag construction for any particular commodity.
UU-S-48 -----	Sacks, shipping paper -----	Type I—Pasted bottom, open mouth (POM). Class 1—Sewn closure. Class 2—Pasted pinch style closure. Type II—Sewn bottom, open mouth. (SOM). Type III—Pasted valve. Type IV—Sewn valve. Type V—Sewn open corner (limited copy missing). Type IV—Pinch style, open mouth. Style A—Flat tube paper shipping sacks. Style B—Gusseted tube paper shipping sacks.	For the handling of bulk type granular, pulverized, crystalline, powdered, or solidifying liquid type commodities within the United States or for ocean shipment. The user must consult table XII of UU-S-48 to determine the minimum sack requirements permitted for any particular commodity.

Table 4-1. Bags and Sacks Used in Military Packaging and Packing—Continued

Specification No.	Title	Type, grade, class, style	Uses
PPP-S-30 ----	Sacks, shipping paper (cushioned or reinforced).	(Styles applicable to all types). Type I—Cushioned, Macerated Paper. Type II—Cushioned, Closed Cell Polyethylene. Type II—Cushioned, Polystyrene. Type IV—Cushioned, Laminated Foam/Paper.	For use as exterior packaging in the shipment of publications and small items where a light cushioning effect and water resistance are required. Also may be used for interior packaging of fragile items such as bottled liquids, radio tubes, and testing and laboratory equipment.

See Table XIII of PPP-B-35 for minimum bag requirements for specific commodities to be packed in inner bags.

Table 4-2. Requirements for Bundling Cotton Mailing Bags

Size of bag	Quantity per bundle	Number of bundles per shipping container
3 x 4 -----	100	24
3 x 5 -----	100	24
4 x 9 -----	100	20
4-1/2 x 8 -----	100	16
5 x 7 -----	100	16
6 x 9 -----	100	12
6-1/2 x 14 -----	50	18
6-1/2 x 10 -----	50	20
7-1/2 x 18 -----	50	12
8 x 10 -----	50	16

distributed between the inner and outer sheets ($\frac{1}{16}$ to $\frac{3}{16}$ inches thick), while Type IV uses a $\frac{1}{8}$ inch polyethylene foam as the cushioning agent. In some cases, it may be desirable to add cushioning or reinforcing materials inside the sack to provide additional protection against internal puncture or breakage.

b. *Procurement.* Cushioned paper sacks are supplied in standard sizes and in the quantities as shown in table 4-3.

4-7. Burlap, Cotton, and Textile Shipping Bags (PPP-B-35)

Textile shipping bags conforming to Specification PPP-B-35 may be made from cotton cloth; burlap cloth; or textile, laminated to paper, polyethylene, or other specified materials. They are used for domestic or oversea shipment of pulverized, powdered, granular, or crystalline supplies of either a hygroscopic or nonhygroscopic nature.

c. *Classification of Textile Bags.* Textile bags are classified into four types based on the material used in their construction (table 4-1 and fig 4-2). The Type III bags are further classified by classes based on the materials used in the layers of the laminated walls of the bags (table 4-1 and fig 4-3). The textiles used in the construction of Type III laminated textile bags are designated by three grades based on the fabric weight,

Table 4-3. Sizes and Quantities of Cushioned Paper Shipping Sacks

Size	Type I No. bags per box	Type II No. bags per box	Type II No. bags per box	Type IV No. bags per box
4 x 8 -----	500	500	500	500
5 x 10 -----	250	500	500	500
6 x 10 -----	250	500	500	500
7-1/4 x 12 -----	100	500	200	250
8-1/2 x 12 -----	100	250	200	250
8-1/2 x 14-1/2 -----	100	250	200	250
9-1/2 x 14-1/2 -----	100	250	200	250
10-1/2 x 16 -----	100	250	100	250
12-1/2 x 19 -----	50	100	100	125
14-1/2 x 20 -----	50	100	100	125

and texture of weave. Grade I is made from cotton sheeting, grade II is of Osnaburg cotton, and grade III is jute burlap. The bags are made in two styles, A and B, based on the means of closing the seams (table 4-1). Bag numbers are assigned to the various types of bags in a series to designate specific construction features. Each construction within a type is given a bag number, such as B-1, C-21, P8, or P58. These construction numbers, found in Tables I, II, and III of PPP-B-35, must be used to determine minimum requirements for burlap, cotton, and laminated textile bags for domestic and export shipments and for special commodity and storage conditions.

b. *Textile Bag Construction Materials.* Textile bags conforming to Specification PPP-B-35 are constructed of a single ply or multiple plies of textiles, paper, polyethylene, and suitable laminants.

(1) *Textiles.* The textiles used in laminated bag construction may be cotton sheeting, cotton Osnaburg (a course heavy sack cloth), or jute burlap cloth. The cotton sheeting material varies in weight and texture. Weights of cotton material are expressed in terms of running or linear yardage per pound of a given loomed width. Burlap material is designated by the weight of one yard of goods of a given width.

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EXAMPLES OF COTTON MAILING BAGS

CLOSING A
COTTON MAILING BAG

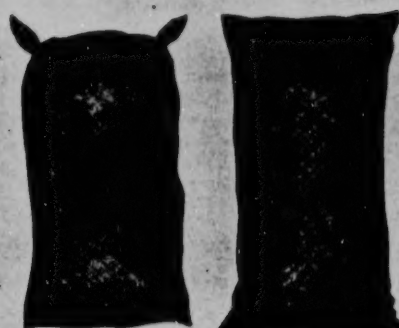
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Figure 4-1. Cotton mailing bags.

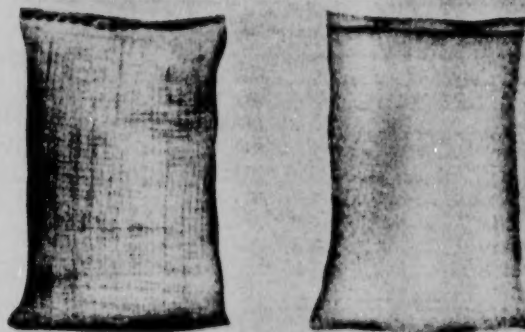
(2) *Paper*. Laminated shipping bags are fabricated in part from either plain or wet strength kraft paper. Kraft (meaning "strong" in German) paper is a long fibered paper, which is widely used and readily available. It may be plain or creped in one direction of the paper, creped in two directions, or creped in one direction and corrugated or pleated in the other. Plain kraft paper is 100 percent unbleached kraft fiber, resin sized. It has not been treated for special qualities such as resistance to rain, scuffing, molten resins, hot asphalt, grease, and water-vapor. Wet strength kraft paper is 100 percent unbleached kraft fiber, resin sized, and distinctly marked for identification purposes with longitudinal red stripes of a minimum width of one-eighth inch, spaced not less than 2 inches nor more than 10 inches apart across the paper width. No other bag construction is striped in this manner.

(3) *Polyethylene*. The polyethylene that is used for Type III, Class 6, bags must be at least 2 mil (0.002-in.) thick to afford the commodities to be packed the desired protection against moisture, odor, and gases.

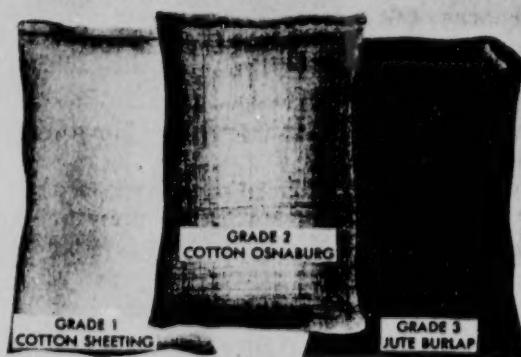
(4) *Laminants*. Usually, asphalt is used as the laminant for textile bags because of its low cost and its moisture-resisting qualities. It is used in varying weights per ream of kraft paper as indi-



TYPE I STANDARD BURLAP



TYPE II STANDARD COTTON



TYPE III LAMINATED TEXTILE BAGS



TYPE IV TEXTILE INNER BAGS

JMPTC 739

Figure 4-2. Types of textiles shipping bags.

cated for classes 1, 2, 3, and 4 in figure 4-3. Other laminants that may be used include latex, polyvinyl acetate, and vegetable glues.

c. *Waterproofing of Textile Bags.* The bags may be waterproofed by inserting a waterproof paper liner or a polyethylene liner inside the textile bag, or be laminating textile and paper with asphalt, latex, or other water-resistant adhesive before manufacturing the bag.

d. *Selection of the Correct Bag.* Since bag constructions vary widely, it is essential that a copy of Specification PPP-B-35 be available. Use must be made of tables XI, XII, and XIII of PPP-B-35 to determine the minimum requirements for a bag to be used in packing any specific commodity. For example, in shipping sodium chloride (rock salt),

table XI shows that a construction number P45A bag may be used for domestic shipments of 50 pounds; but a P6A bag is required for an overseas shipment of 100 pounds to a civilian agency, while either a P12, style B or A, or a P15, style B or A, is required for military shipments. Table XII of PPP-B-35 lists the bag constructions required for sugar, flour, cereals in bulk, etc. If commodities such as flour, salt, beans, peas, rice, or sugar are to be packed in units of 50 pounds or less, table XIII of PPP-B-35 must be used.

e. *Requirements for Packing.* The commodity may be packed in one of several ways. It may be packed in bulk in either 50- or 100-pound lots in type I, II or IV bags. It may be packed in cotton cloth inner bags in lots of 5 or 10 pounds. These

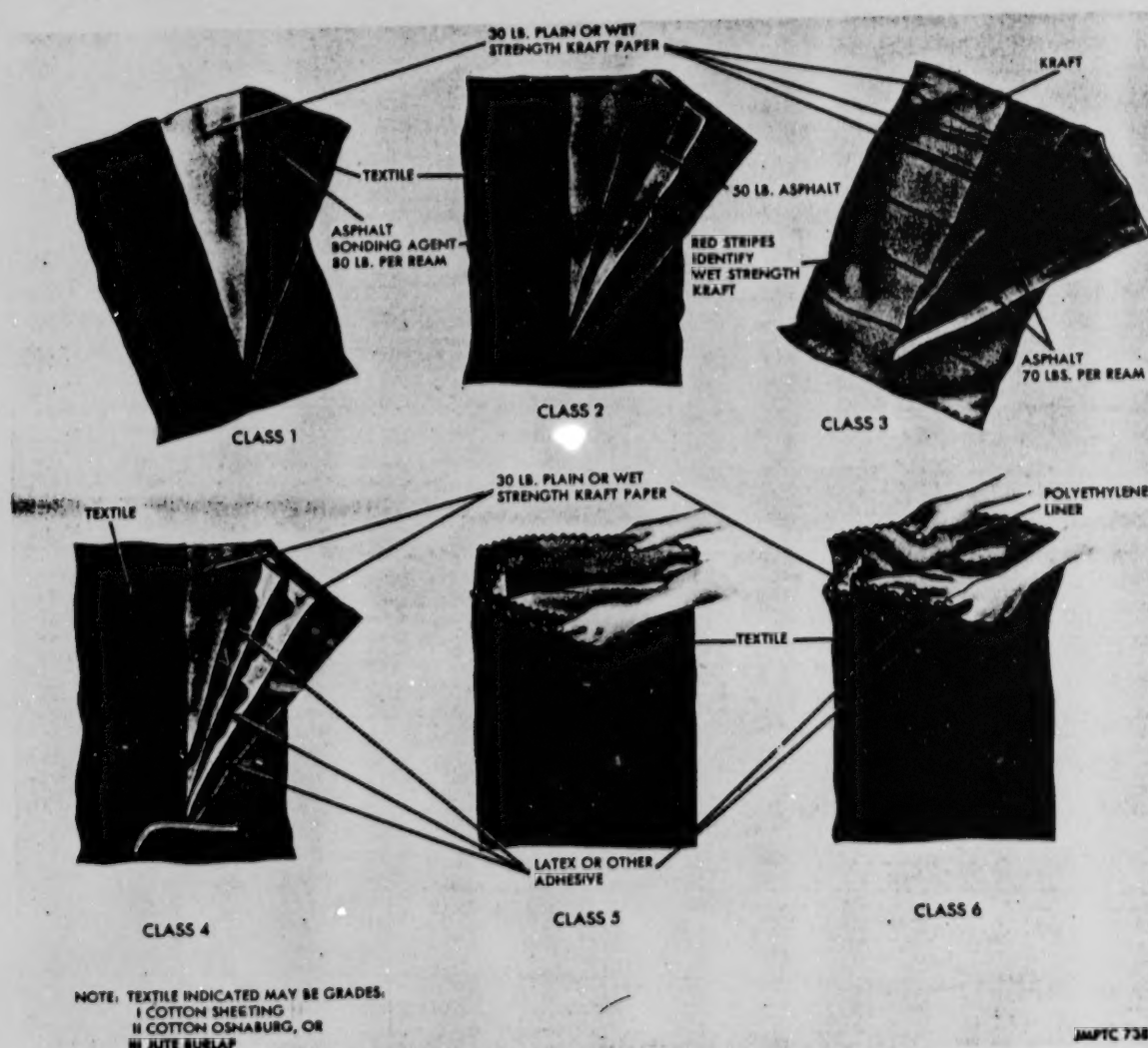


Figure 4-3. Classes of textile shipping bags.

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inner cloth bags are in turn packed in type III laminated textile bags as described below.

(1) *Packing 5- or 10-pound bags.* Twelve filled and closed type IV cotton cloth bags of 5 pounds capacity, or six filled and closed 10-pound, type IV, cotton cloth bags are packed into a type III shipping bag. Place one on top the other with the faces of the inner bags down and the ends of the inner bags adjacent to the side edges of the outer shipping bag (fig 4-4). The laminated shipping bag should inclose the contents, leaving no space that will permit shifting of the inclosed inner bags.

(2) *Packing of 50-pound bags.* One filled and closed type IV cotton bag of 50 pounds is packed into a laminated textile shipping bag. Place the factory closed end down and have the side edge adjacent to the side edge of the outer bag. Be sure the outer and inner bags are of proper relative sizes so that after packing with the required quantity of the commodity, there is sufficient space left to allow the inner bag to conform to the shape of the outer bag during handling and stacking.

f. Requirements for Closure of Types I, II, and IV Bags. Types I, II, and IV bags are closed after filling by sewing a line not less than 1 inch from the top of the cloth and parallel to the top. When liners are used with these bags, they are closed (fig 4-5) as follows:

(1) *Paper bag liners.* After filling the combined bags, the top edges of the paper liners are brought together and folded down against the top of the contents with a minimum of three flat folds allowing sufficient slack for the product to shift. Close the outer bag by sewing.

(2) *Polyethylene bag liners.* After filling the combined bags, gather the top of the polyethylene

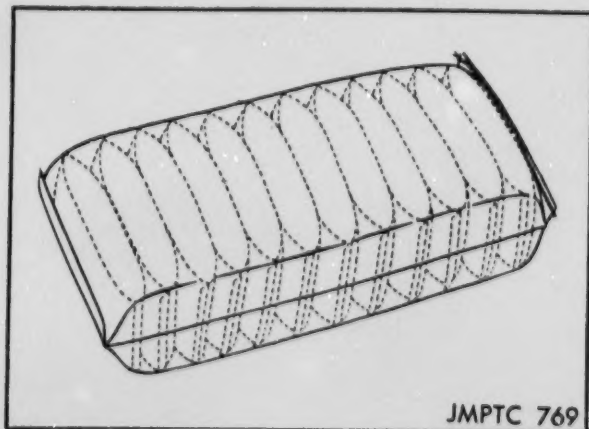


Figure 4-4. Packing inner bags in a laminated textile bag.

liner together and tie with heavy cord or, if equipment is available, the top may be heat sealed. Close the outer bag by sewing. If types I, II, or IV bags are provided with valves, fold the tuck-in-sleeve down and back into the valve space directly under the sleeve so that it will securely hold against sifting.

g. Requirements for Closure of Type III Bags.

After filling, type III bags may be closed by sewing with a flat seam or a single turn-over seam and waterproofed by dipping the sewn seams in microcrystalline wax or a blend of paraffin wax and polyethylene, at least one-fourth of an inch beyond the upper edge of the seam on the bag body. Alternatively, the bag may be sewn with a strip of paper-asphalt-textile material 2½ inches wide, cemented over the sewing with asphalt (fig 4-5).

4-8. Paper Shipping Sacks (UU-S-48)

Paper shipping sacks are made in a great variety of sizes and constructions to meet the needs for the shipment of wide range of bulk materials. These paper sacks can be custom-made to suit the demands of the product, or the filling, packing, shipping, and storage conditions (table 4-1).

a. Advantages of Paper Shipping Sacks. For shipping bulk materials up to 110 pounds, these shipping sacks are ideal. They are easy to fill and empty. They constitute one-man sized loads for handling. They are low in tare weight and occupy a minimum storage space prior to use. The protection required for the commodity can be built in by the bag manufacturer as required. Paper shipping sacks can be designed to protect the product against weather changes, water, insects, rodent excreta, chemical reactions, and foreign substances. The basic material, kraft paper, is widely used and readily available.

b. Classification of Paper Shipping Sacks. Paper shipping sacks conforming to Specification UU-S-48 are classified into types and classes based on bottom construction, filling device, or closure. Two styles applicable to all types are also available (table 4-1).

c. Paper Shipping Sack Construction. The successive walls of a shipping sack are arranged and fabricated in tube form one within the other so that each wall bears its share of the burden. The number of walls vary from two to five in accordance with the shipping sack construction numbers detailed in tables I and II of Specification UU-S-48. It has been found that greater flexibility and strength are obtained by using several walls of

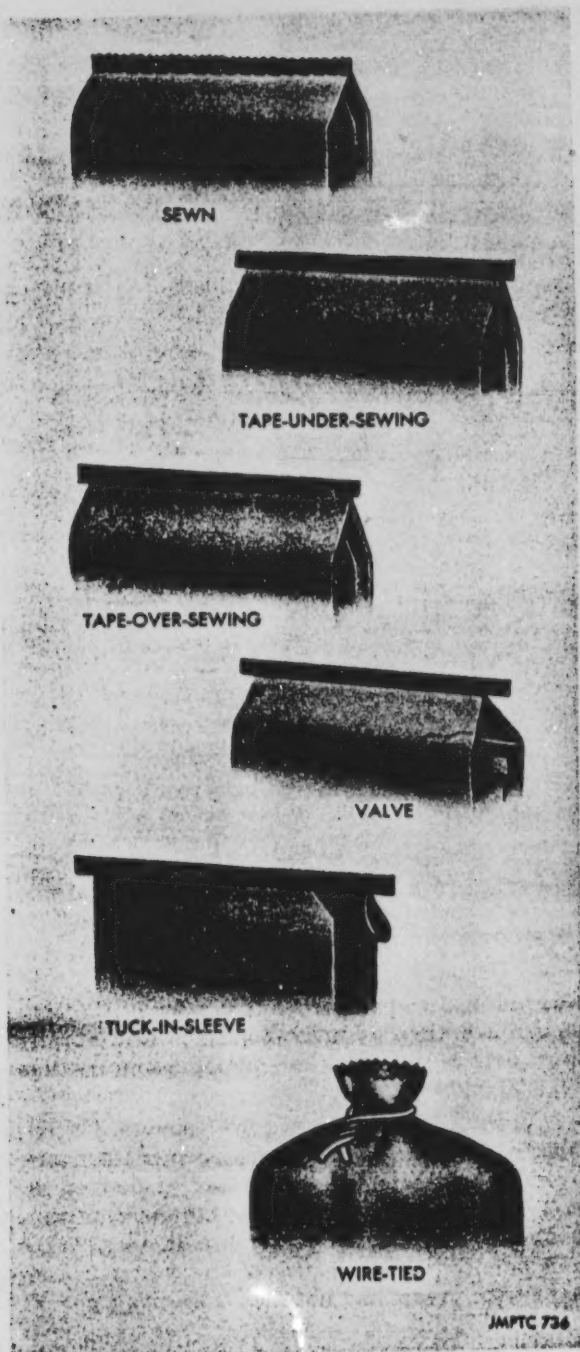


Figure 4-5. Types of closures of sacks.

relatively light-weight, rather than few walls of heavier paper. For this reason, the average heavy-duty multiwall shipping sack is constructed of a number of sheets ranging from 50 to 70 pounds basis weight paper. (Basis weight is the weight of one ream—3000 square feet—of paper.)

d. *Construction Materials.* Paper shipping sacks may be constructed either wholly or in part from several classes of paper. The paper may be plain heavy-duty shipping sack kraft made from all sulfate pulp, without other fiber which has not been treated by coloring, bleaching, creping, coating, spraying, laminating, or impregnating for special qualities. The paper may also be plain wet strength, asphalt laminated, MB (moisture barrier) coated or lined, in regular or extensible varieties to provide special strength and moisture-proof characteristics to a specific sack according to its construction number. When necessary, an insect repellent treatment may be applied to shipping sacks. Such treatment will be applied to the outside surface of the sack and in accordance with Military Specification MIL-T-21330.

e. *Construction Numbers.* Since each commodity differs in chemical and physical characteristics, and the factors of availability of packing equipment, value of product shipping conditions, number of transfers, atmospheric conditions, and exposure to the elements must all be taken into consideration before determining the construction of a shipping sack, a great number of combinations of constructions have been developed. These constructions are to be found in tables I and II of Specification UU-S-48. Tables I and II delineate the different constructions permitted, numbering 1 to 18 and 1x to 18x, respectively. Sacks from either table may be selected for packing of commodities for shipment, handling, indeterminate storage and worldwide redistribution (Level A), or for packing of commodities destined for multiple domestic shipments, handling and covered storage, and for ocean shipments and covered storage at destination where the end use of the commodity is to be at the initial overseas receiving activity (Level B). Sacks for Level A must be of wet strength kraft paper.

f. *Description of Sack Types.* The types of sacks furnished by Specification UU-S-48 have the following features and uses:

(1) *Type I, pasted bottom, open mouth (POM).* This may be either a flat tube nongusseted sack often called an *open mouth satchel bottom sack*, or it may be a gusseted sack with a factory made square, pasted bottom, called the *open mouth automatic sack* (type I, fig 4-6).

(2) *Type II, sewn bottom, open mouth (SOM).* This sack may be either gusseted at the sides or of flat tube construction. The bottoms are formed by sewing through reinforcing tape. The mouth is left open for filling (type II, fig 4-6).

(3) *Type III, pasted valve.* This valve may be

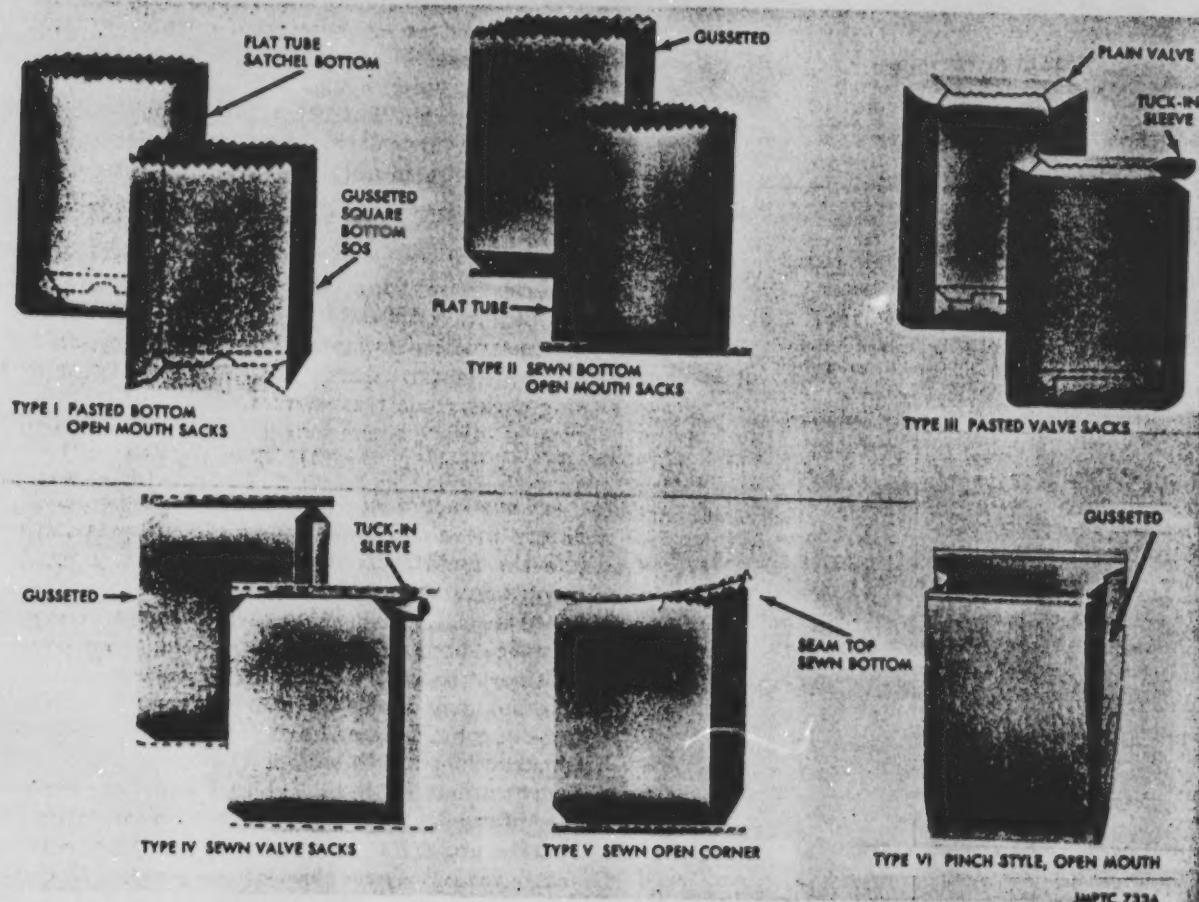


Figure 4-6. Types of paper shipping sacks.

made by forming satchel folds at top and bottom and pasting. A valve opening is left in one corner. Special valve filling equipment is necessary for these sacks. The valve may be of several types depending on the commodity to be packed. Two common types are the plain valve and the tuck-in-sleeve valve. The plain valve is held closed by the commodity. The tuck-in-sleeve must be tucked in manually to provide a good seal (type III, fig 4-6).

(4) *Type IV, sewn valve.* These sacks are closed at top and bottom by sewing with a reinforcing tape. A valve in one corner provides for filling. The valve may be plain or with a tuck-in-sleeve (type IV, fig 4-6).

(5) *Type V, sewn, open corner.* This is a special purpose sack, intermediate between the valve and the open mouth type sack. These sacks are used for commodities which are packed while in a molten state, and which solidify into a block which takes the shape and size of the sack when the material cools. Filling is usually done by a pipe

inserted in the open corner. The plies at the open corner are then brought together and stapled down over this closure for further reinforcement (type V, fig 4-6).

(6) *Type VI, pinch style, open mouth (PSOM).* This bag is made from a gusseted tube. The ends of which are shingled or stepped (including the gussets) on opposite sides. The bottom closure is realized by scoring, folding, and sealing with a hot melt adhesive. The closure of the top is usually made with preapplied hot melt adhesive (type VI, fig 4-6).

g. Selection of Appropriate Sacks. To ship any specific commodity in paper shipping sacks conforming to UU-S-48, it is essential to consult table XII of the specification to determine the sack construction numbers for the commodity for each packing level and the shipping weights. The construction for any sack number so given is found in table I and II of the specification. As an illustration, if granular sugar is destined for shipment in

bulk overseas, sack numbers of 4-4x, 10-10x, and 14-14x are indicated in table XII, depending upon weight. Their constructions are found in tables I and II of the specification.

h. Storage of Unfilled Paper Sacks. Paper shipping sacks give their best service during packing and closing operations when the moisture content of the paper is 6 to 8 percent. Storage prior to filling can mean the destruction of a paper shipping sack unless the humidity is kept at that level. If the sack is allowed to dry out, it becomes weak and brittle. Brittleness can be detected by shaking a sack briskly, if it rattles sharply, it is too dry. Sacks that are too dry upon receipt from the manufacturer, should be spread out in a humidified room, or on a covered loading platform during rainy weather to allow the sacks to absorb the moisture needed to regain their flexibility and strength. The problem of dryness is very serious when sacks are filled by automatic equipment. Unlike human operators, the machine makes no allowances for brittle sacks and ruptured sacks and spilled contents are the result.

i. Filling Paper Shipping Sacks. The wrong filling equipment can damage paper shipping sacks. These sacks are filled in three ways: with gravity feed, auger packers, or valve packers.

(1) *Gravity feed equipment.* Gravity feed equipment is used mostly on open mouth sacks

into which the feeder drops the product. The product must be free flowing. Such products as sand, grits, beans, and peas are typical for this type filling.

(2) *Auger packer.* The auger packer pushes the product into an open mouth sack. It is used for materials that are not free flowing in themselves, such as flour.

(3) *Valve packers.* There are four types of valve packers: The gravity feed, belt, auger, and impeller. All have a spout which inserts into the valve of sewn or pasted valve sacks. The gravity feed valve packer is used on free flowing materials. With the belt packer, the material is poured into a channel between a rotating pulley and a moving belt which conveys it into the sack. This is used for granular materials. The auger valve packer forces nonfree flowing material into the sack horizontally through the spout. Flour, starch, and similar materials are packed with this equipment. Impeller valve packers have an impeller wheel, mounted either vertical or horizontal to the sack which drives the dense powders (cement, plaster, or lime) into the sack.

j. Closure of Paper Shipping Sacks. The top closure, formed by the packer, varies according to the commodity packed and the sack type. Basically, the closures are made by sewing or pasting. The specification must be consulted for details.

CHAPTER 5

PAILS AND DRUMS

5-1. Description, Classification, and Selection Factors

a. Description:

(1) *Pails.* Pails are cylindrical containers made of metal or plastic, with or without a bail (handle). They have a capacity of 1 to 12 gallons. Metal pails are constructed of 29 gage or heavier metal. The sides and bottoms of the plastic pails are integral units having a minimum thickness of 0.045 inches and designed so they can be easily stacked. Pails may have fixed heads employing pour spouts of various designs or have full removable heads.

(2) *Drums.* Drums are cylindrical, straight-walled containers made of metal, plastic fiber or plywood, or a combination of these materials. Drums may be provided with rolling hoops pressed or expanded from the body of the drum, or I bars welded to the body. Drums have fixed or removable heads.

Note. Cans are lightweight containers made of metal, paperboard, pulpboard, or a combination of metal and paperboard or pulpboard. Since cans usually are associated with unit packaging, information concerning them is found in volume I of this manual.

b. Classification. Pails and drums are classified as to usage, that is, interior or exterior containers, and reusable and nonreusable containers. They are also classified as to composition—metal and nonmetal.

(1) Interior and exterior containers.

(a) Interior. Interior containers are covered in volume I of this manual.

(b) Exterior. These containers consist of pails, reusable type metal containers, and drums. Exterior containers are designed to withstand rough usage. They may be palletized for convenience in handling.

(2) Reusable and nonreusable containers.

(a) Reusable. Certain metal containers and drums are designed for reuse. The reusable type is very convenient for the return shipment of repairable items. This feature is particularly advantageous in cases where repairable instruments or

accessories can be packed for shipment to the maintenance overhaul activity in the container in which the replacement item was received. Multiple trip pails and drums may, under certain conditions, be refilled and reused for the shipment of liquid, powdered or granular commodities.

(b) Nonreusable. Single-trip containers usually are discarded after their first use. One type, the strippable drum, is filled with a hot liquid which solidifies after cooling. At destination, the drum is torn away from the enclosed product. Other single-trip containers, designed of light gage metal, are discarded after the first trip because of Department of Transportation (DOT) Regulations, or because the general physical condition of the container would not warrant another trip.

(3) Metal and nonmetal containers. Pails and drums usually are made from metal, although some may be made from fiberboard. The most common metal used for drums is mild steel. Some drums, however, are made of aluminum, nickel, stainless steel, various alloys, or plastics.

c. Use and Selection Factors.

(1) Use. A wide range of items and commodities are adaptable for shipping in pails and drums. Liquids, semiliquids, semisolids, granular, flaked, and powdered materials, and solids may be shipped in specified types of these containers. Fragile items and precision instruments may be given the high degree of protection they require by the use of cans or drums. Dangerous materials, such as corrosive liquids, flammable solids, flammable liquids, and acids which cannot be shipped in any other type of container may be shipped in approved types of pails and drums.

(2) Selection. When selecting a pail or drum, it must be remembered that these containers are structurally rigid in design and are dustproof. They may also be waterproof or water-vaporproof. They are easy to mark and afford excellent physical protection to contents during shipment and storage. Pails and drums may be less susceptible to pilferage than some other types of containers. Care must be taken when selecting containers.

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This is particularly true when selecting a container for shipment of dangerous items; it is also true when selecting the correct container for other items. For example, a square item in a cylindrical container takes about $1\frac{1}{2}$ times the cube required for the same item when packed in a square container. In addition to the loss of valuable cube, excess dunnage is required to fill the voids when a container of the wrong shape is used.

5-2. Molded Plastic Polyethylene Drums (MIL-D-40030)

a. Description. These interior drums are made of natural color polyethylene, molded in one piece, are cubical or cylindrical in shape, and have either a one-flange opening or two-flange opening.

b. Classification. Polyethylene drums are classified as Style A, cubical, and Style B, cylindrical. Style A has only one size, size 1, which has a nominal capacity of 5 gallons. Style B has sizes 1, 2A, 2B, 3, and 4 with nominal capacities of 5, 15, 15, 30, and 55 gallons, respectively. Both Styles A and B comply with specifications 2S of the Department of Transportation (DOT) Regulations.

c. Use.

(1) These drums are intended for use as containers for liquids, powders, or pastes. They are not intended for use with strong oxidizing liquids or aromatic or aliphatic hydrocarbons, but are suitable for some organic and inorganic acids, alcohols, and alkalis. In all cases, the chemical should not be packed in a polyethylene drum if the boiling point of the chemical approximates, or is lower than, the anticipated storage temperature. Table II of Specification MIL-D-40030 must be consulted to determine the specific materials that may be shipped or stored in these drums.

(2) After filling, Style A drums are packed in fiberboard lined nailed wood boxes for level A shipments, while Style B drums are packed in type I or II steel drums. The type I steel drum is constructed to leave the closure flange of the polyethylene drum exposed, and the type II steel drum fully incloses the polyethylene drum. Steel drums must conform to specification 5B or 6J of the Department of Transportation (DOT) Regulations.

(3) Packing for level B shipments is the same as for level A, except that Style A polyethylene drums are packed in type CF or type SF, class domestic fiberboard box, conforming to Specification PPP-B-636 (para 2-1).

(4) Polyethylene drums should be protected

from exposure to sunlight (ultraviolet rays), since ultraviolet rays accelerate the aging of the polyethylene.

d. Closures. Size 1 drums have a one-flanged opening. Size 2, 3, and 4 drums have a two-flanged opening. The drums are provided with polyethylene plugs for each opening. All plugs are constructed so that they may be tightened with a standard plug wrench and do not interfere with the placement of an outer cap. Outer caps are provided for each opening. The caps are rigid metal or plastic screw-type closures which, when hand-tight, will prevent foreign matter from coming in contact with the polyethylene flanges.

5-3. Reusable Molded Polyethylene Container (DOT 34 and MIL-D-43703)

a. Description. These polyethylene containers range in capacities from 5 gallons to 30 gallons. They are required to have a minimum thickness of 0.045 inches for containers having capacities from 5 gallons through $6\frac{1}{2}$ gallons, 0.075 inch thickness from 15 gallon containers and a thickness of 0.125 inches for 30 gallon drums. These containers are reusable and are designed for use without overpack. Removable heads are not authorized. Ultraviolet light protection is provided by impregnation of polyethylene with carbon black or other equally efficient pigments or inhibitors. These additives must be compatible with lading and must retain their effectiveness for the life of the container. Other materials may be added (such as reinforced metal chimes, tops and bottoms) provided they do not adversely affect the physical properties of the container.

b. Use. These molded polyethylene drums are reusable for holding all types of dry and liquid products, especially acids and other sensitive commodities.

c. Closure. Openings shall not exceed 2.7 inches in diameter for any size DOT 34 container. Closures shall be of material resistant to lading and adequate to prevent leakage under conditions incident to transportation and handling. Vented closures are authorized when specified.

d. Marking. Each container must be permanently marked by embossment in letters and figures at least $\frac{1}{2}$ inch in size with month and year of manufacture and the rated capacity of the container. For example, DOT-34-5-6/74 to indicate a container of 5 gallons capacity made in June 1974. These marks shall be understood to certify that the container complies with all specification requirements.

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5-4. Steel Shipping Pails, 1 Through 12 Gallons (PPP-P-704)

a. *Description.* These pails are cylindrical containers constructed of 26-gage or heavier steel. They usually are furnished with a bail (handle). Pails may have full removable heads or fixed (tight) heads which are provided with spouts of various designs (fig 5-1).

b. *Classification.* Pails furnished in accordance with Specification PPP-P-704 are classified as Type I, tight head pails; Type II, lug cover pails; and Type III, lug cover nesting pails. (Types I and II are shown in fig 5-1). The classes, metal gage, capacities and applicable DOT specification, or Rule 40 of the Uniform Freight Classification and the National Motor Freight Classification are shown in table 5-1. These pails are furnished with straight sides (Types I and II) and tapered sides with one or two beads (Type III).

c. Use.

(1) *Statutory requirements.* Shipping containers conforming to Military and Federal specifications must conform also to Department of



Figure 5-1. Tight head and lug covered pails.

Transportation Regulation: Code of Federal Regulations, Title 46; Title 49; Uniform Freight Classifi-

Table 5-1. PPP-P-704 Steel Shipping Pails—1 Through 12 Gallons

Type	Class	Gage	Applicable specification	Capacity available in gallons
I—Tight head	1	28	DOT-37A-40 or etc.	1 through 4
	2	26	Rule 40 and 260 DOT-37B-60	1 through 5
	3	24	Rule 40 and 260 DOT-17E	1 through 5
	4	24	DOT-17C or DOT-5B	1 through 5
	5	24	Rule 40 and 260	1 through 5
	6	24	DOT-37B-80	6
	7	24	Rule 40 and 260	6
	8	22	DOT-5	5
	9	22	DOT-17E	10
	10	22	Rule 40 and 260	10
	11	20	DOT-17C	10
	12	20	DOT-5	10
	13	20	Rule 40 and 260	12
II—Lug Cover	1	26	DOT-37A-60	1 through 5
	2	26	Rule 40 and 260	1 through 6
	3	24	DOT-37A-80	1 through 5
	4	24	Rule 40 and 260	1 through 10
	5	24	DOT-37A-160	6 through 10
	6	22	Rule 40 and 260	8 and 10
	7	20	Rule 40 and 260	12
	8	24/20	DOT-17H	2-1/2 through 5
	9	28/26	DOT-37C-80	5
	10	38	DOT-37A-40	1 through 4
	11	24	DOT-17C	5
	12	20	DOT-17C	5 through 10
III—Lug cover—nesting pail	1	26	DOT-37A-60	5
	2	26	Rule 40 and 260	5
	3	24	DOT-37A-80	5
	4	24	Rule 40 and 260	5
	5	28/26	DOT-37C-80	5

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cation, Rule 40; and the National Motor Freight Classification, Rule 260. The DOT requirements are for the shipment of dangerous materials. These requirements are issued in a tariff by the Bureau of Explosives. This tariff specifies the type of container for the shipment of dangerous materials. These containers are referred by a DOT specification number. For example, a DOT-17E pail covers light steel shipping containers and nonreturnable (single-trip) containers (table 5-1). Nonreturnable containers cannot be reused unless they are retested and approved by the Bureau of Explosives. Rule 40 and Rule 260 apply to containers carrying "nonregulatory" products not classified as dangerous.

(2) *Application.* Liquid products are usually shipped in Type I, tight head pails, which are provided with spouts of various designs for pouring. Solids, such as powdered, granular, and flaked materials; semisolids, such as heavy greases; and semiliquids, such as molasses, are shipped in Type II and III, lug cover pails, because the heads can be removed to gain access to the contents (fig 5-1).

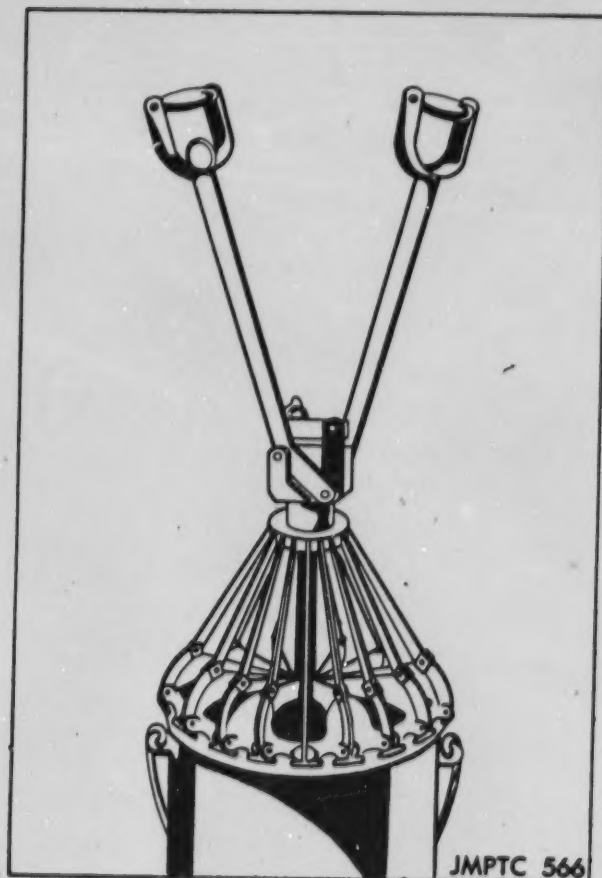


Figure 5-2. Lug cover closing machine.

d. *Closure.* Type I lids are permanently secured at time of manufacture. The spout closures are accomplished immediately following the filling operation. Careful inspection should be made during handling, shipment, and storage to assure that these spouts have not received damage and are still maintaining an adequate seal. Lug covers may be secured by a tool specifically designed to accomplish closure on this type of container. Figure 5-2 shows a machine which will close all lugs in one operation, while figure 5-3 shows a small handtool which closes two lugs at a time. Hands, pliers, hammers, or other improvised means are not satisfactory and should not be used.

5-5. Metal Containers With Polyethylene Inserts (PPP-C-1337)

a. *Description.* These containers, ranging in capacity from 5 to 55 gallons, are best described as a drum within a drum. The assembled container is a unit comprised of a polyethylene insert and a steel drum over-pack, neither of which is intended to be used separately (fig 5-4). The covers of the outer packs are fully removable. These units are considered single-trip containers.

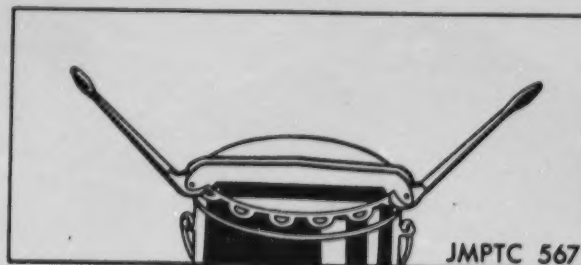


Figure 5-3. Hand closing tool for lug covers.



Figure 5-4. Plastic lined composite container.

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b. *Classification.* These containers are furnished as Type I containers for surface shipment only and Type II to be used for both air and surface shipment. Table 5-2 shows the classes available under both types, depending upon the rated capacity of the insert in gallons, together with the corresponding Department of Transportation specification number, and the minimum thickness of the inserts and steel overpacks.

c. *Use.* These containers are intended for shipment of liquids that do not physically or chemically affect or are not affected by polyethylene. These containers are not intended to be used for the shipment of concentrated hydrochloric acid. Liquids having a vapor pressure of more than 16 pounds per square inch absolute at 115° F. are not to be packed in the composite container. Care must be exercised in assembling the polyethylene insert in the steel overpack and the filling of the assembled container.

d. *Closures.* For all class 1 and 2 containers the closures neck must provide adequate provision for pouring contents over edge of steel drum or provide flexible pour spouts for each container to

accomplish this. Closure necks of the polyethylene inserts for the different types and classes are as described in tables 5-2 and 5-3. All covers shall be secured with locking rings. Type 1, Classes 1 and 2, may be equipped with lug type covers and locking rings.

5-6. Metal Shipping and Storage Drums (Mil-D-6054)

a. *Description.* These reusable steel shipping and storage drums are fabricated of 18 and 22 gage steel and incorporate a full removable (recessed or dome style) cover. Bolted-ring or lever lock closures are used to seal the cover onto the drum body, (fig 5-5). Gaskets for the covers may be tubular or solid. The covers, gaskets and locking rings are interchangeable within each diameter group. Rolling hoops, which increase the strength, rigidity, and ease of handling, also provide the means of anchoring internal dunnage through the use of split expanding steel rings which fit into the grooves (fig 5-6). When properly sealed, the drums provide a highly effective water-vaporproof container, thus affording a de-

Table 5-2. Closures, PPP-C-1337 Containers

Type	Class 1 5 gallon	Class 2 15 gallon	Class 3 30 gallon	Class 4 55 gallon
I	Crimped on flexible type closure. Closure accessible through steel cover.		2-inch N. P. T. primary closure and 3/4 inch N. P. T. vent closure. May be crimped on threaded type or may be attached to and integral with polyethylene insert.	
II	Closure fully enclosed, attached to or integral with top of polyethylene insert; 38mm (MIN) 70MM (MAX) externally threaded closure neck with screw cap or plug; cap flush with top for shipping and capable of being lifted up to pour over edge of steel pail or drum.		Closure fully enclosed, attached to or integral with top of polyethylene inserts; 2-inch N. P. T. primary closure and 3/4-inch N. P. T. vent closure.	

Table 5-3. Composite Container Requirements (PPP-C-1337)

	Polyethylene Insert Minimum thickness	Department of Transportation specification	Metal container Department of Transportation specification	Minimum Thickness ²			Rated (marked) capacity Polyethylene insert gallon
				Body	Bottom	Covers	
Type I:							
1.....	.010	2U	37P	26 GA	26 GA	24 GA	5
2.....	.015	2U	37P	22 GA	22 GA	19 GA ¹	15
3.....	.015	2U	6D	19 GA	19 GA	19 GA	30
4.....	.015	2U	6D	18 GA	18 GA	18 GA	55
Type II:							
1.....	.015	2U	6D	22 GA	22 GA	20 GA ²	5
2.....	.015	2U	6D	20 GA	20 GA	20 GA	15
2A.....	.030	2SL	6D	20 GA	20 GA	20 GA	15
3.....	.030	2SL	6D	19 GA	19 GA	19 GA	30
4.....	.040	2SL	6D	18 GA	18 GA	18 GA	55

¹ Twenty (20) gage authorized.

² Heavier gage than 6D.

³ Design and metal thickness of type II container bodies, heads, and locking rings may be increased if necessary to meet the no leak requirements when tested in accordance with 4.6.10 of PPP-C-1337.

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Figure 5-5. Bolted ring and lever actuated type closures.



Figure 5-6. Internal locking rings in position.

gree of protection suitable for Method IA and Method II preservation (vol I).

b. *Classification.* The drums are available in various capacities ranging from 3 to 80 gallons, and from 40 to 250 pounds gross weight. The drums are available with inside diameters ranging from 10.50 inches to 30 inches, and inside usable heights ranging from 8.08 to 41.12 inches. The capacities and dimensions, which are available in different combinations, are specified in Military Standards MS27683 and MS27684.

c. *Use.* These metal drums are intended to be used for storage and shipment of military material. Drums are required by test to withstand internal pressure of 15.0 pounds per square inch (psi), which will allow them to be used for packing of hazardous materials for transportation by military aircraft. These diameter drums are also used as overpacks for shipments by air of containers which will not meet 15 psi. All size drums are suitable for all methods of preservation where a rigid container is specified. The use and selection of metal shipping and storage drums are affected by the following factors:

(1) *Size and capacity.* There is no specific rule for the selection of a container for a particular item. It is obvious, however, that a container will

be selected which will be adequate to contain the item and its blocking and cushioning, yet allow sufficient clearance between the item and the container, or between the blocking and the container walls, to prevent damage to the item when the drum is handled roughly. The container must not be too large, as this will involve the use of extra space and weight. This is a disadvantage when a large number of such drums are to be shipped or stored.

(2) *Internal locking rings.* The split steel locking ring is designed to fit snugly within the rolling hoop of a metal container and provide a circular flange support for interior blocking (fig 5-7). Care must be used in the design of the interior blocking or other fittings to prevent displacement of the locking ring when loaded. Without some safety device, the locking ring may be loosened by rough handling of the container due to the load imposed on the ring. Figure 5-7 illustrates a safety ring made of plywood. If the item being packed precludes the use of a safety ring, the same function may be performed by using three blocks equally spaced around the internal locking ring and secured to the dunnage by screws. This permits the removal of the blocks for unpacking.

(3) *Cup-type inserts.* The cup-type metal insert was developed primarily as a mount for generators and starters for metal container packing, but it may be adapted to other items. Figure 5-8 shows the metal cup, with plywood fastened to the two ends to aid in blocking while figure 5-9 shows the cup in position, anchored between the locking ring and container cover. It will be noted that the stepped rim of the insert forms the safety to

prevent the ring kicking out of the rolling hoop. The numerous bolt holes through the cup allow it to be bolted to various items as required.

(4) *Crate-type inserts.* The crate-type metal insert is shown in figure 5-10. In use, the item being packed is bolted to two adjacent side mem-

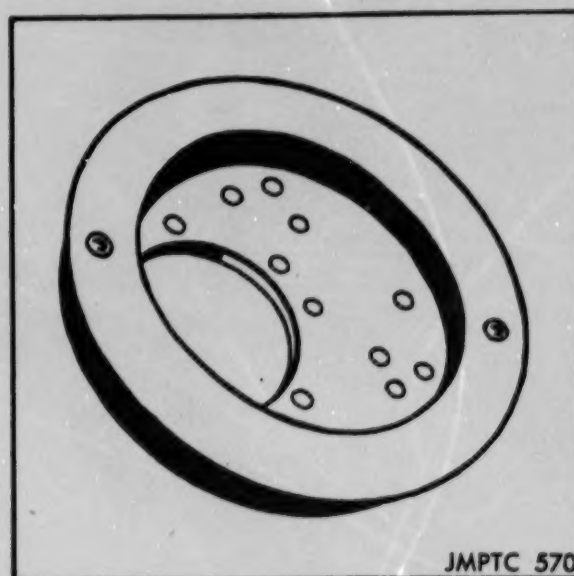


Figure 5-8. Cup-type metal insert.

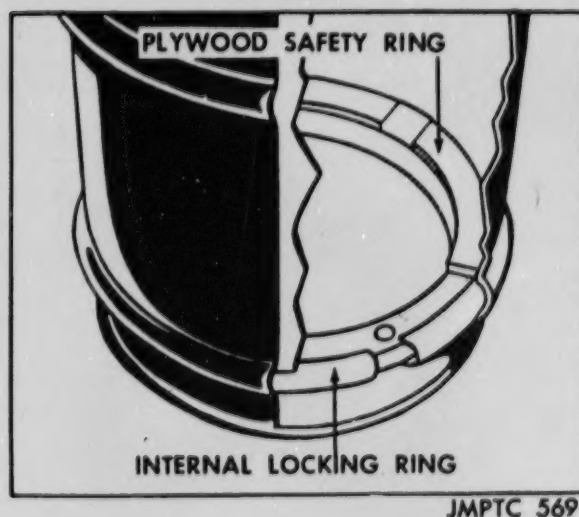


Figure 5-7. Use of internal locking ring.

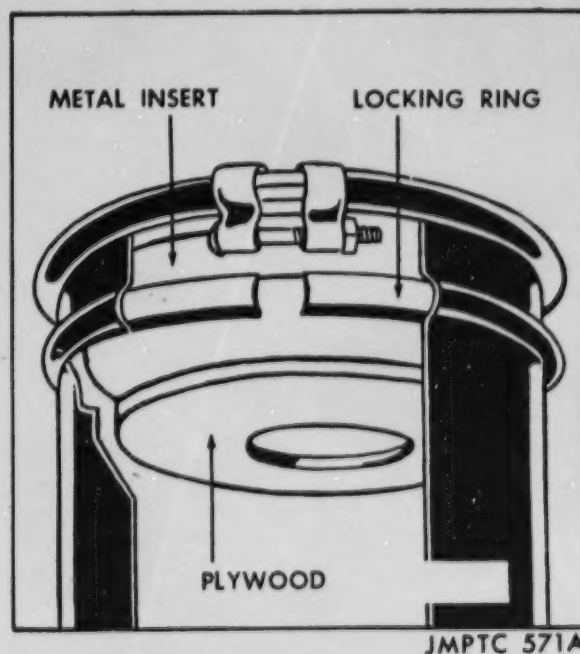


Figure 5-9. Cup-type insert locked in place.

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Figure 5-10. Item installed in crate-type insert.

bers. Plywood disks on the ends of the insert provide some cushioning. The base of the item packed will be insulated from the insert with barrier material conforming to Specification MIL-B-121, Grade A to preclude the possibility of corrosion from reaction of two dissimilar metals. The maximum weight of the packed item should

not exceed 25 pounds for the 10 $\frac{1}{2}$ -inch diameter insert, or 30 pounds for the 13 $\frac{1}{2}$ -inch insert.

d. *Closure.* There are two styles of closure for these drums. They are the bolted ring closure, and the lever activated locking closure. Closures are made in one or the other of the following manners:

(1) *Bolted-ring closure.* The closure may be made in two ways. A device may be used which encircles the locking ring and applies pressure uniformly around the circumference of the ring. The closure is effected by tightening the bolt and nut after uniform pressure is applied at all points around the ring. Care should be taken that the gasket is properly seated in the groove of the cover prior to closure. Alternately, closure may be made by tightening the closure bolt (fig 5-11). The locking ring is tapped at various points about the closure ring while the closure bolt is being tightened. The tightening is continued until at least a minimum torque of 6 foot-pounds plus or minus one-half is applied. In lieu of the specified torque indicating device, closure of an exterior metal container having a slotted-head bolt may be accomplished by using a common screwdriver having an overall length of approximately 17 inches. If this procedure is followed, a spot check of torque with a torque indicating device should be made to assure adequate tensioning. Drums used for shipping commodities by Parcel Post will have the bolt end and protruding edges of the closure ring wrapped, taped, cushioned or otherwise securely covered to prevent damage to postal employees, mail bags, and other containers during shipment. Containers shall be overpacked in fiberboard boxes when this extra precaution is considered necessary. When overpacked, containers shall be secured within the fiberboard box with fiberboard or other suitable dunnage.

(2) *Lever actuated locking closure.* When specified in the contract or purchase order a lever actuated type locking ring may be used instead of the nut and bolt type locking ring. Use may be made of a device which encircles the locking ring and applies pressure uniformly about the circumference of the locking ring. The closure is then affected by closing the locking lever and then the wire and lead seal lever which locks the locking lever in position. When the encircling device is not available for use, tension is applied by the locking lever and the ring is tapped repeatedly around the circumference until the ring is seated and the lever is in a locking position. The lever is then locked into place by the wire and lead seal lever lock.



Figure 5-11. Tapping locking ring while tightening bolt to insure an effective seal.

e. *Sealing.* Sealing of the container is effected by means of a wire and metal seal which is applied after the closure is complete. Drill $\frac{3}{32}$ -inch diameter holes in each locking ring lug if they are not already predrilled. The sealing wire is inserted through the holes and the loose ends are twisted together tightly, after which the seal is crimped over the twisted ends of the wire.

f. *Repair and Reuse.* The components of the metal shipping and storage drums are repaired and reused as follows:

(1) *Containers, cover, ring, and gasket.* Due to the welded construction of an exterior type metal container, dents are considered repairable even though a seam or joint is involved. Dents are removed, painted surfaces retouched, and the container reused or returned to stock. If the container is distorted beyond practical repair, or has a dented or otherwise damaged sealing lip, it is unfit for further use and should be handled accordingly. Damage to covers, gaskets, and locking rings is discussed in chapter 5, volume 1.

(2) *Metal inserts and dunnage.* It is not normally considered advisable to repair metal inserts or dunnage, due to the fact that once distorted or deformed, the metal insert would probably be weaker if bent back into the original shape, and thus be incapable of affording the necessary protection. If bent back and reinforced, the spring rate of the material might be greatly changed, thus transmitting any shock directly to the part to be packed and causing damage. However, in an

emergency they may be repaired under competent engineering supervision. Immediately upon removal of an item from a metal insert type mount, the interior locking rings and metal inserts must be returned to stock, unless required for immediate reuse. All inserts and interior locking rings are stocked and handled as separate items, and never as component parts of the container assembly.

5-7. Metal Drums (Standard) (Miscellaneous)

a. *Description.* Metal drums are cylindrical, single-wall shipping containers with a capacity which usually ranges from 12 to 110 gallons, 55 gallons being the most common capacity. Metal drums are equipped with rolling hoops which provide additional strength to the side wall and provide for ease of handling. The rolling hoops may be parallel to each other or be offset to facilitate closer nesting for palletization and carloading. Metal drums may have full removable heads or tight heads (fixed) (fig 5-12). A drum with a tight head is provided with a 2-inch diameter bung and $\frac{3}{4}$ -inch diameter vent hold for filling and emptying. These openings may be on the drum head or in the drum body. Drums may be unlined or lined with lacquer, varnish, enamel and plastics, rubber, lead, or aluminum.

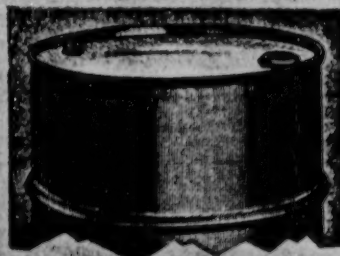
b. *Classification.* The Armed Forces use many kinds of drums for the shipment of various materials. When shipping hazardous materials, the Federal or Military specification in each case equals or exceeds the DOT specification requirement for the kind of drum required for that particular material. Listed in table 5-2 are the coordinated Federal and Military drum specifications and titles, and the corresponding DOT specification. Uniform Freight Classification rule 40, or National Motor Freight Classification rule 260. Figure 5-12 shows the types of drums classified in Federal Specification PPP-D-729 and the corresponding DOT-5B. DOT designates the DOT 17E and DOT-37A drums as single trip containers when used to ship specified hazardous materials.

c. *Use.* The tight (fixed) head drums are primarily used for the shipment of liquids. Emptying may be through either the filler or vent hold, although the filler hole is most commonly utilized. A spout may be affixed to the threaded portion of the hole to facilitate emptying. A pump, either hand or hydraulically operated, may be utilized in the hole. Greases, dry powdered, flaked or granular materials, etc., may be shipped in a full removable head drum. The full removable head drum provides the easiest access to the contents.

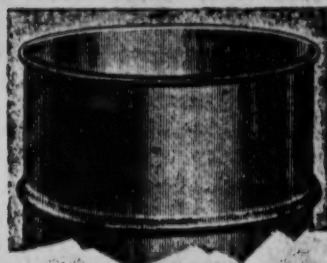
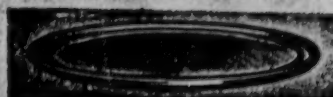
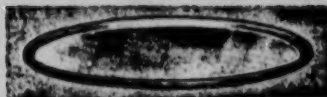
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TIGHT HEAD WITH CHIME
REINFORCEMENT
PPP-D-729, TYPE I DOT-5B



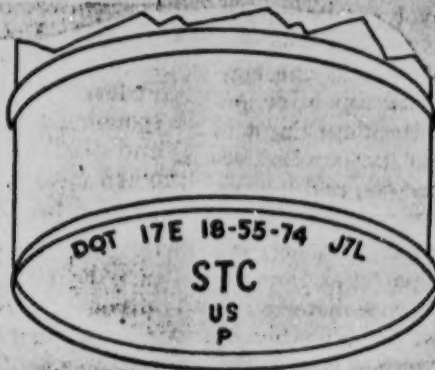
TIGHT HEAD WITHOUT CHIME
REINFORCEMENT
PPP-D-729, TYPE II DOT 17E



FULL REMOVABLE COVER WITH
BOLTED TYPE LOCKING RING
PPP-D-729, TYPE III
UFC RULE 40 NMFC RULE 260



FULL REMOVABLE COVER WITH
BOLTED TYPE LOCKING RING
(DROP FORGED LUG)
PPP-D-729, TYPE IV DOT 17H



TYPICAL MARKINGS ON BOTTOM HEAD

JMFTC 22678

Figure 5-12. Types of drum closures and typical markings (PPP-D-729).

Table 5-4. Specifications and Titles of Metal Drums

Federal or military specification number and title	DOT specification, Uniform Freight Classification rule, or National Motor Freight Classification rule
PPP-D-700 Drum: Metal 55 gallon (For acid and corrosive liquids). Type I Type II Type III	DOT-5A Steel barrel or drum, removable head containers not authorized. DOT-5C (Same as above). DOT-5D Steel barrel or drums, lined. Removable heads which will pass all required tests are authorized.
PPP-D-705 Drums, metal shipping steel (over 16 and under 30 gallon). Type I, 30 gallon Type II, 16 gallon Type III, 120 # grease Type IV, 30 gallon Type V, 30 gallon Type VI, 16 gallon	DOT-17E Steel drums, single trip container, removable head containers not authorized. DOT-17E (Same as above). UFC Rule 40 NMFC Rule 260 UFC Rule 40 NMFC Rule 260 DOT-17H Steel drums, single trip container, removable head required. UFC Rule 40 NMFC 260
PPP-D-711 Drum, metal shipping steel, lightweight (55 gallon).	Not applicable.
PPP-D-729 Drum, metal, 55 gallon (for shipment of noncorrosive materials). Type I Type II Type III Type IV	DOT-5B Steel barrels or drums. Removable head containers which will pass all required tests are authorized. DOT-17E Steel drums, single trip container. Removable head containers not authorized. UFC Rule 40 NMFC Rule 260 DOT-17H Steel drums, single trip container. Removable head required.
PPP-D-723 Drums, metal, reconditioned 55 gallon (for shipment of noncorrosive materials). Type I Type II Type III Type IV	DOT-5B Steel barrels or drums. Removable head containers which will pass all required tests are authorized. DOT-17E Steel drums, single trip container. Removable head containers not authorized. UFC Rule 40 NMFC Rule 260 DOT-17H Steel drums, single trip container, removable head required.
PPP-D-736 Drums, steel, shipping, Type 6A and 6B (for phosphorous, white or yellow, dry or in water). Type I, 30 gallon Type II, 30 gallon Type III, 30 gallon Type IV, 30 gallon Type V, 30 gallon Type VI, 55 gallon	DOT-6A Steel barrels or drums. Removable head containers which will pass all required tests are authorized. DOT-6A (Same as above). DOT-6B Steel barrels or drums. Removable head containers which will pass all required tests are authorized. DOT-6B (Same as above). DOT-17C 18 gage. DOT-17C 16 gage.
PPP-D-1152 Drums, steel, 55 gallon (24 and 21 gage) Reinforced.	DOT-37D Steel drums.
MIL-D-195 Drum, steel calcium carbide, 100-pound capacity.	UFC Rule 40 NMFC Rule 260

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d. Reuse. Most metal drums are initially filled at the manufacturer's plant and are reusable except for single-trip containers. When empty, the drums may be returned to destination for refilling. If refilling is done by the initial user, care should be taken not to reuse drums which have been used to ship dangerous materials, until such drums are cleaned and tested in accordance DOT regulations. Failure to do so may create a serious health hazard. When filling drums with dangerous materials, only DOT specified type drums may be used for that commodity. The DOT drum specification number, the name, initial, or symbol of the manufacturer; the letters "US" to indicate that the drum is the property of the Government; the letters "STC" if the drum is a single trip container; and a numerical indication of the thinnest gage of metal used in the construction, the capacity of the drum in gallons, and the year of manufacture are embossed on the bottom of the drum (fig 5-12). For example, 18-55-74 means that drum is 18 gage metal, 55-gallon capacity, and was made in 1974. When filling the drums, the contents may not exceed the marked capacity minus 2 percent for outage.

5-8. Fiber Drums (PPP-D-723)

a. Description. Fiber drums are cylindrical shipping containers with bodies made of fiberboard, either lapped or parallel wound (convolutely) in

the form of a hollow cylinder. They may be either single unit or telescopic body type. The heads are of metal, wood, plywood, or fiberboard. There are many characteristics of fiber drums which give them advantages over other types of containers. Included among these are cleanliness, durability, low uniform tare weight, retard temperature fluctuation, easy opening and closing, water and moisture resistance, stackability, easy handling, product protection and wide range of diameters and heights. Fiber drums are easily opened and re-closed.

b. Classification. Fiber drums are available in the types, grades, and classes shown in table 5-5.

c. Use. The intended uses are also shown in table 5-5. The other factors covered by this paragraph must also be observed.

(1) *Application.* The size and weight capacities for the three types of drums vary according to specification requirements: therefore, the specification requirements should be consulted for details. Basically, however, the maximum capacity for both Type I and II drums, Grade A, and B, is 550 pounds weight of contents and 75 gallons, except for Type I, Grade A, Class 2, which has a maximum net weight of 200 pounds. For Grade C, the maximum capacity is 55 gallons. Type III, Grade A, is limited to 400 pounds and 75 gallons, while Grade C is limited to 115 pounds and 55 gallons. Although dyestuffs, chemicals, waxes, re-

Table 5-5. PPP-D-723 Fiber Drums

Type	Grade	Class
I-Domestic -----	A—For dry or solid materials B—For semiliquids C—For hot-poured materials that solidify on cooling D—For rolled or cylindrical items E—For liquids or articles in liquids (non-regulated)	1—Regular construction 2—Foil laminated construction 3—Integral plastic lining 4—Semirigid plastic component 5—Molded rigid one-piece plastic component
II-Normal oversea -----	A—For dry of solid materials B—For semiliquid materials C—For hot-poured materials that solidify on cooling D—For rolled or cylindrical items E—For liquids or articles in liquids (non-regulated)	3—Integral plastic lining 4—Semirigid plastic component 5—Molded rigid one-piece plastic component
III-Military oversea -----	A—For dry or solid materials C—For hot-poured materials that solidify on cooling D—For rolled or cylindrical items	1—Regular construction 2—Foil laminated construction 6—For contents having a minimum melting point of 120° F. 7—For contents having a minimum melting point of 160° F.

sins, asphalt, etc., can be placed directly into the drums without further consideration, fragile and delicate items, such as electronic equipment, require cushioning with plastic foam, foam rubber, bonded fibers, or similar materials. The increased use of fiber drums for the shipment of coiled wire, tubing, and rolled or cylindrical items, is an indication of the trend towards fuller utilization of fiber drums.

(2) *Compliance marking.* In addition and adjacent to the drum manufacturer's markings required by Uniform Freight Classification, National Motor Freight Classification or DOT rules or regulations, each drum is stamped or printed in black capital letters not less than $\frac{3}{16}$ -inch in height with information concerning the type, class, grade, specification number, etc. For example, the information for the Type I drum is shown below:

Type I
(DOMESTIC TYPE)
COMPLIES WITH FED. SPEC. PPP-D-723G
FOR DOMESTIC SHIPMENT_____

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GRADE _____ CLASS _____
MAX. WT. OF CONTENTS _____ LBS.
MAX. CAPACITY OF CONTENTS _____ GAL.

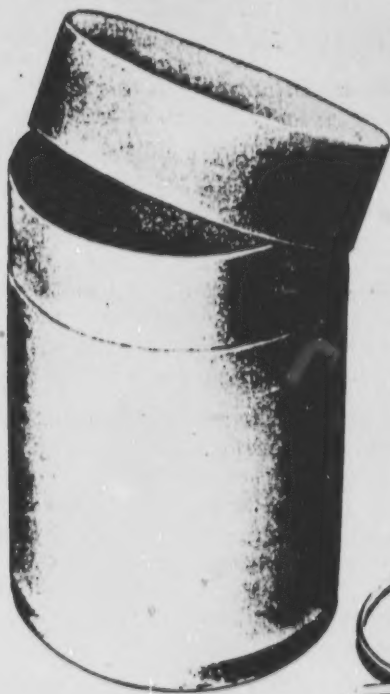
In addition, Grade D drums shall have stencilled or printed on the cover and side wall in letters not less than $\frac{3}{4}$ -inch in height, the following precautionary markings:

STAND ON END
KEEP COOL AND DRY

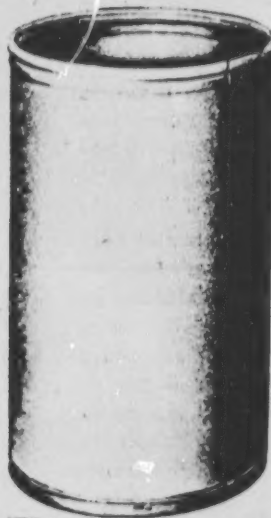
Only contents of the type, grade, and class as indicated in the compliance markings are to be placed in these drums. The weight and capacity must also conform to these requirements.

d. Closure. The closure of fiber drums must be such that they may be opened and reclosed by hand or simple tools. These are three types of closures which are commonly used. They are the friction-type or telescopic slip on covers, which are secured with pressure sensitive tape, lever-activated locking bands, and the metal clip or lug closure (fig 5-13).

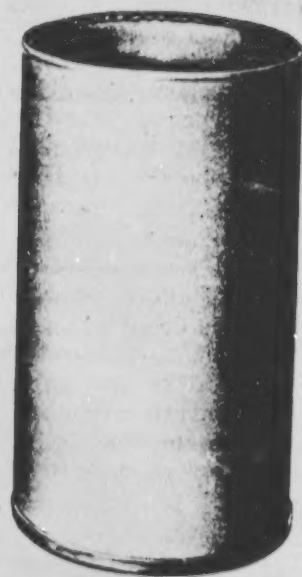
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FRICTION TYPE SLIP-ON
COVER WHICH IS SECURED
WITH GUMMED OR
PRESSURE SENSITIVE TAPE



LEVER ACTUATED LOCKING-
RING TYPE COVER



PRESS-ON TYPE COVER
HELD IN PLACE WITH
METAL CLIPS

JMPTC 573

Figure 5-13. Types of fiber drum closures.

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CHAPTER 6

CRATES

6-1. Introduction to Crates

a. Nomenclature and Related Terms. Crates are rigid containers constructed of structural members fastened together to protect the contents. Crate design involves numerous names and terms which must be defined if the construction of crates is to be explained without confusion. When the names of the separate components are known, although they differ in various specifications and drawings, their functions and relationship to each other are more easily understood. In order that both general and detail design requirements may be clearly understood, reference to items described in (1) and (2) below is recommended.

(1) *Nomenclature.*

Baffle. A piece of plywood, wood, or metal placed over ventilation holes to deflect air or water entering the crate.

Bottom Sheathing. Boards nailed to the bottom surface of the frame members of a sill base. Also known as *flooring*.

Bridging. Members of the same depth as joists or sills placed at right angles to the intermediate longitudinal or crosswise sills or headers to prevent lateral turning or buckling of the joists or sills.

Cleats. Auxiliary reinforcements for plywood panels placed between vertical struts to strengthen the panel.

Covered Crate. A crate with open-type frame with an outside covering of plywood or paper-overlaid veneer.

Crate Base. The bottom load bearing unit of a crate.

Crate Covering. A lightweight material fastened to the frame of an open crate to give more positive weatherproofing than is offered by an open crate and shroud.

Diagonals. Frame members positioned between parallel frame members and placed at angles of nearly 45° to the latter.

Diagonal Floorboards. Usually 1-inch boards, cut at 45° angle to the skids and placed between the forklift areas.

End Frame Members. Members of the top panel of an open crate, placed crosswise at each end of the top.

End Sills. Members forming the ends of a sill frame.

Filler Strips. Boards placed across the ends of thin, nonload bearing floorboards which fill the space below the lower frame member of the sides.

Floor Members. Boards and timbers nailed or bolted to the top of the skids forming a platform for the contents and a bottom closure for the crates.

Forklift Area. Area extending 42 inches in from each end of the crate, usually floored with 2-inch boards.

Frame Members. Those wood members which form the fundamental structure of the crate.

Gusset Plate. A square piece, usually plywood, placed at the junction of the diagonals for reinforcement.

Hanger, Metal. Metal strapping formed in a manner to support intermediate sills on a sill-type crate or joists of the top.

Headers or End Cross Members (Open Crate). Cross members attached at the end of the skids which hold the skids together. Also longitudinal members at each end of top joists.

Horizontal Braces. Members positioned between struts and parallel to upper and lower frame members of the sides or ends.

Horizontal Top Bracing Joist Support. Horizontal member attached to the frame members in which the top joists rest.

Intermediate Crosswise Sills. Full length members located between the end sills and parallel to them.

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Intermediate Frame Members. Members of the top panel of an open crate located between and parallel to the side frames of the top.

Intermediate Longitudinal Sills. Full length members located between the side sills and parallel to them.

Intermediate Skids. Full length beams located between and parallel to the skids.

Joists. Members extending across the crate that support the top and prevent crushing when grab hooks are used.

Joists Supports. Members, usually 2 x 4, nailed to the frame under each joist and extending to the floor.

Kick Blocks. Short members attached at the junction of the corner post and upper or lower edge member. They are used on end panels having no braces or those with a single diagonal brace.

Lag Bolt Reinforcing Strap. Galvanized strapping drilled to take lag bolts and nailed to the inner face of the sheathing at the center line of the skid and header.

Load Bearing Floor Members. Heavier or reinforced floorboards used to hold the concentrated weight of the crate load.

Lower Frame Member. Horizontal frame member at the lower edge of the side and end panels. Formerly called *lower edge member*.

Open Crate. A crate formed of frame members only, without exterior sheathing attached.

Reinforcing Straps. Metal strapping applied at the corners or base corners to reinforce and fasten the panels together.

Rubbing Strips. Boards nailed to the underside of skids or bottom sheathing.

Sheathed Crate. A crate in which the frame members are completely covered with sheathing.

Sheathing. Material such as plywood, lumber, or fiberboard nailed to the frame of a crate across all openings to add strength to the crate, or to prevent loss of contents, pilferage, or entry of dirt, water, etc., into the crate.

Side Frame Members. Members of the top panel of an open crate, placed lengthwise of each side of the top.

Side Sills. The members forming the sides of a sill base crate.

Sills. The continuous frame members of a sill base.

Sill Base. A crate which has its frame members (sills) built on the inside of the crate to which the bottom sheathing is attached.

Sill Bridging. Members of the same depth as the sills placed at right angles to the intermediate lengthwise or crosswise sills of a sill base to prevent twisting or buckling.

Skids. The outside longer beams of a skid base which support the weight of the crate and contents.

Skid Base. A crate base which has its longer beams on the outside.

Sleeper. Reinforcing members secured to the underside of the floorboards, at right angles to the floorboards to provide secure anchorage for the item.

Spacers. Members which position the ends of joist or sills.

Spreaders. Members placed at right angles to the floorboards, between the item and the floorboards, to distribute the load over a wider area.

Sling Notches. Open spaces between the ends of the rubbing strips and the ends of the crate, or cutaway sections at the ends of the skids.

Struts. Vertical frame members between the upper and lower frame members.

Top Joist Spacers. Short members nailed between the top joists, to the inside face of the upper frame members, which act as end bridging.

Top Sheathing. Board or plywood forming the closure of the top.

Upper Frame Member or Upper Edge Member. Horizontal frame member at the upper edge of the side and end panels.

(2) Terms.

Actual Size Lumber. The true dimension of a piece of lumber as measured with a scale.

Center of Balance. The point along the length of a crate at which it would balance on a fulcrum, placed at right angles to the skids or sills.

End Grain Nailing. Nails driven parallel to the grain of the wood.

Gross Weight. Total weight of the crate and its contents when ready for shipment.

Holddowns. Devices constructed of wood or metal, used to secure the item to the base of the crate.

Liner. Waterproof barrier material placed between the frame and the sheathing.

Net Weight. The weight of the item alone, excluding dunnage, wrappings, or containers.

Nominal Size Lumber. Dimension of lumber before it is dressed.

Overdriving. Driving nails into wood so that the heads sink below the surface of the wood.

Side Grain Nailing. Nails driven at right angles to the grain of the wood.

Tare Weight. The weight of the crate, including dunnage, holddowns, and packing materials.

Underdriving. Driving nails into wood so that the heads protrude above the surface of the wood.

b. Classification of Crates. Crates are grouped into several categories. They may be open or sheathed (fig 6-1). Crates may be nondemountable, single trip crates of nailed construction, or bolted, reusable, demountable crates. Crates may be designed for domestic use only, or for both domestic and oversea shipments. Some crates are designed for general use and others are constructed in accordance with a specification for a particular item. Of course, the classification of a crate may include a combination of several of the above factors.

(1) *Open crates.* An open crate is a container formed of frame members only, without exterior sheathing attached. When plywood or paper-overlaid veneer is used to provide additional weather protection, they may be called covered crates as opposed to sheathed crates. The open crates discussed in this section are the most widely used (fig 6-2, 6-3, and 6-4).

(a) *Small open crates.* Small open crates may be subdivided into the following categories:

1. *Flat Crates.* These crates are normally not more than 12 feet in length, 4 feet in width, and 2 feet in height, as illustrated in figures 6-2 and 6-3 Type II. The net weight of contents should not exceed 500 pounds. However, there are exceptions to these requirements which are explained in the footnote of table 6-3.

2. *Lightweight crates.* These crates are designed for net weight of contents not exceeding 250 pounds. The size is limited to 4 feet in length 3 feet in width, and 3 feet in height (fig 6-2 and 6-3, Type I).

3. *Medium weight crates.* Crates in this classification are normally designed for a net weight of contents not exceeding 1,000 pounds. The size is limited to 6 feet in length, 4 feet in height, and 4 feet in width (fig 6-2, Type IV).

4. *Heavy weight crates.* These crates are normally designed for a net weight of contents not exceeding 4,000 pounds. The size is limited to 32 feet in length, 6 feet in width, and 10 feet in height (fig 6-2 and 6-3, Type V).

(b) *Large open crates.* For military use, two kinds have been selected.

1. *Nailed crates.* These crates are designed for a net weight of contents ranging up to 12,000 pounds. The maximum size limit is not to exceed 16 feet in length, 8 feet in width, and 8 feet in height (fig 6-4).

2. *Bolted crates.* These crates are designed for reuse with a net weight of contents ranging up to 16,000 pounds. These crates are designed with a size limit not to exceed 40 feet in length, 8 feet in width, and 16 feet in height (fig 6-5).

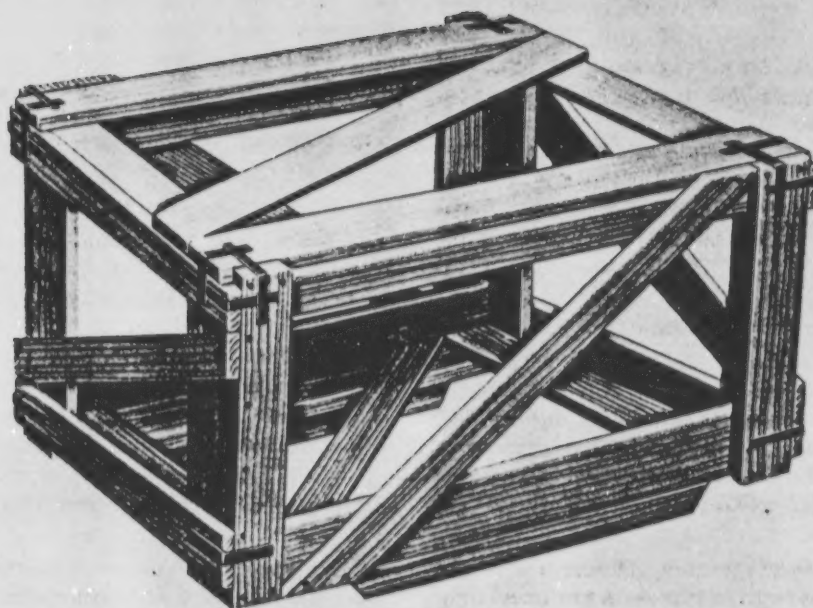
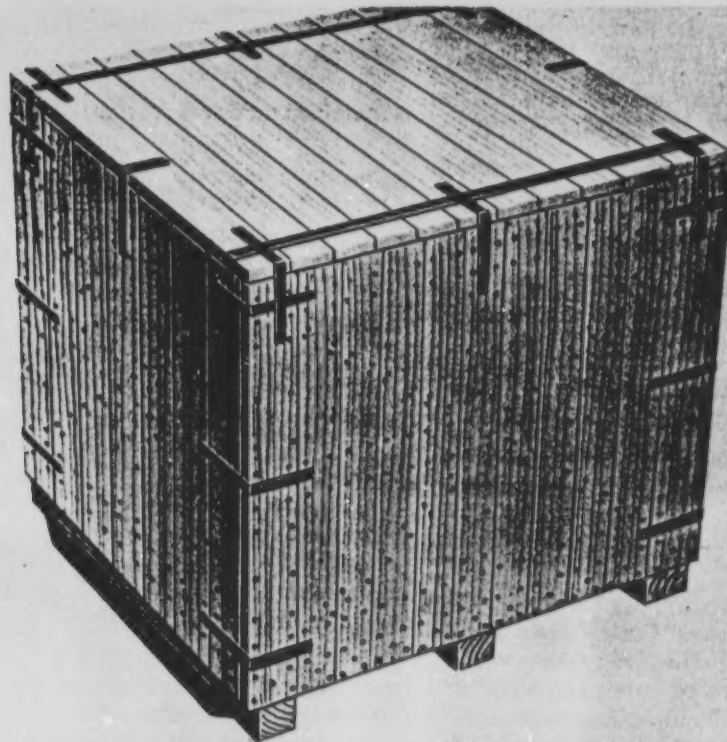
(2) *Sheathed crates.* A sheathed crate is similar to an open crate except that the frame members are completely covered with sheathing material, such as lumber or plywood, fastened to the frame. This adds strength to the crate, prevents loss of contents, reduces pilferage, and prevents the entry of dirt, water, etc. The main difference between a nailed wood box and a sheathed crate is that the top, bottom, and side faceboards of a nailed wood box provides the main structural strength, whereas in a crate, the frame members sustain the load and provide the strength. Many sheathed crate designs exist in our military system; however, the designs selected for this section are considered to be the most widely and generally used (fig 6-6).

(a) *Sheathed nailed crates.* These crates are not designed for reuse and are constructed in the same manner as bolted crates with minor exceptions. The crates should not exceed 30 feet in length, 9 feet in width, and 10 feet in height. The net weight of contents may range up to 30,000 pounds. These limitations may be exceeded, however, when the size and weight of the item require a larger crate.

(b) *Sheathed bolted crates.* All bolted crates are designed for reuse. The size and weight limitations are the same as for the nailed crates.

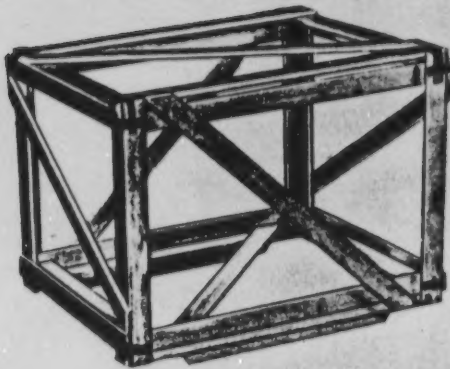
(3) *Special use crates.* Crates in this classification are of special design for specific items. These crates may be fabricated of metal or wood, either open, sheathed, nailed, or bolted. Crate dimensions and weight will vary depending upon the

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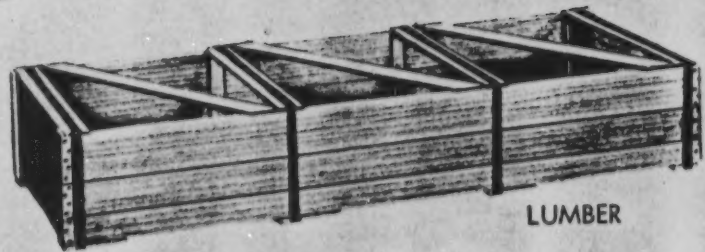


JMPTC 244A

Figure 6-1. Open and sheathed crates.



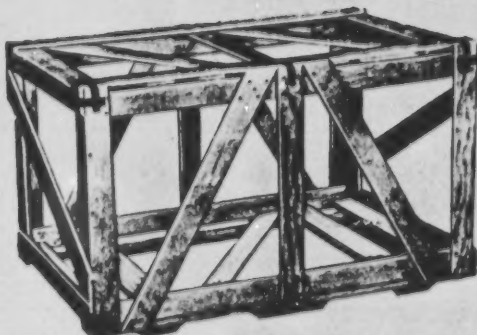
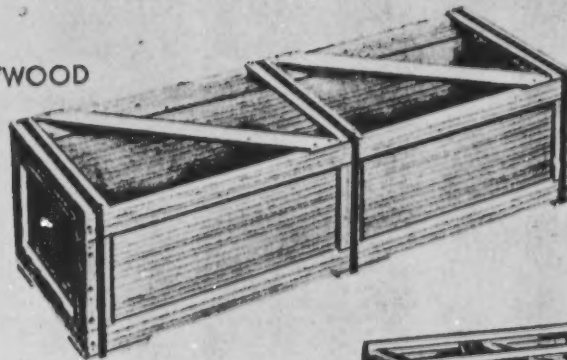
TYPE I STYLE A



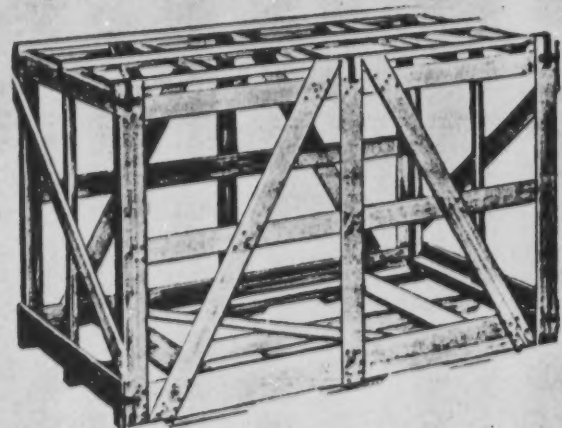
LUMBER

TYPE II STYLE A

PLYWOOD



TYPE IV STYLE A

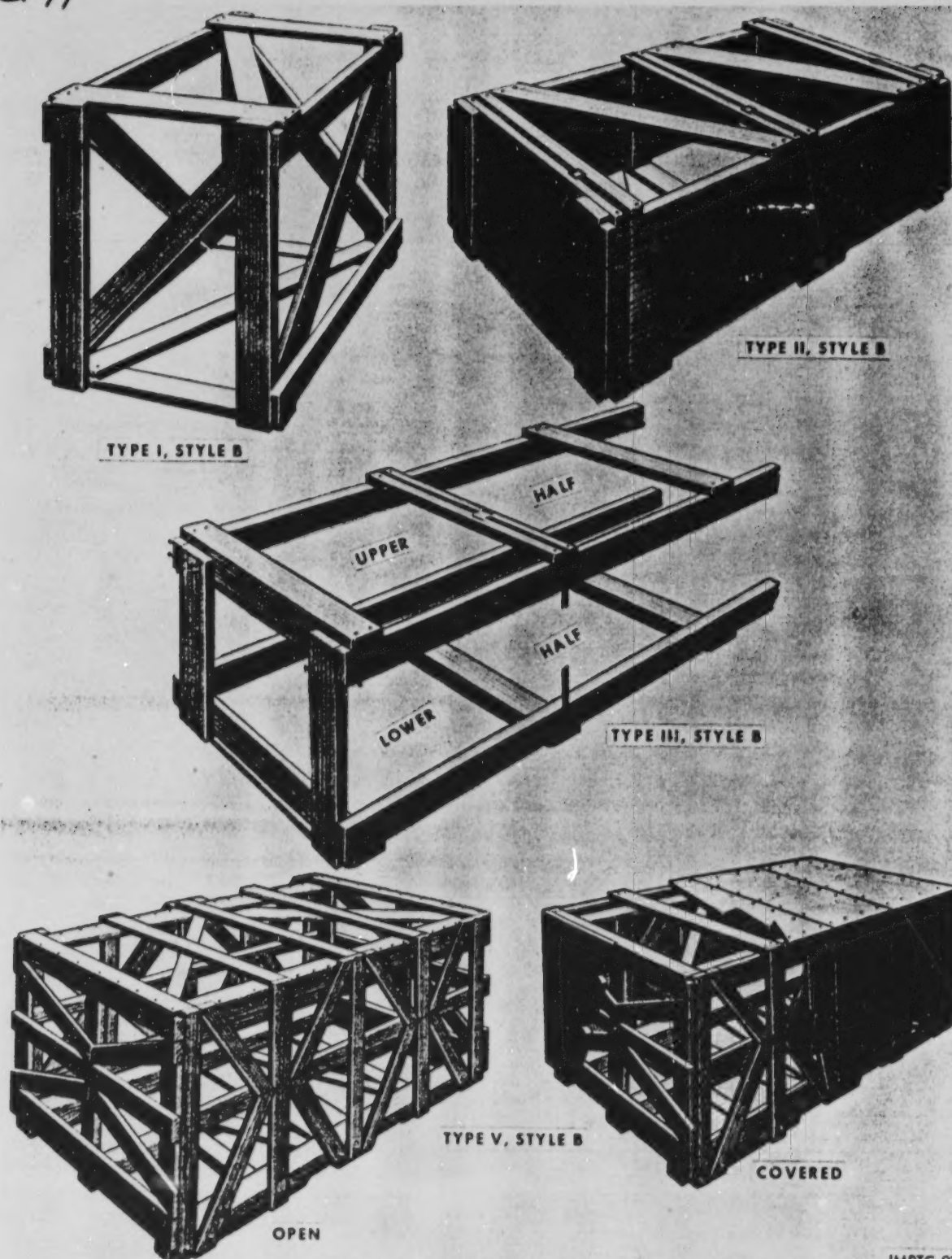


TYPE V STYLE A

JMPTC 973

Figure 6-2. Styles of open crates (PPP-C-650).

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JMPTC 972

Figure 6-3. Styles of open crates (PPP-C-650).

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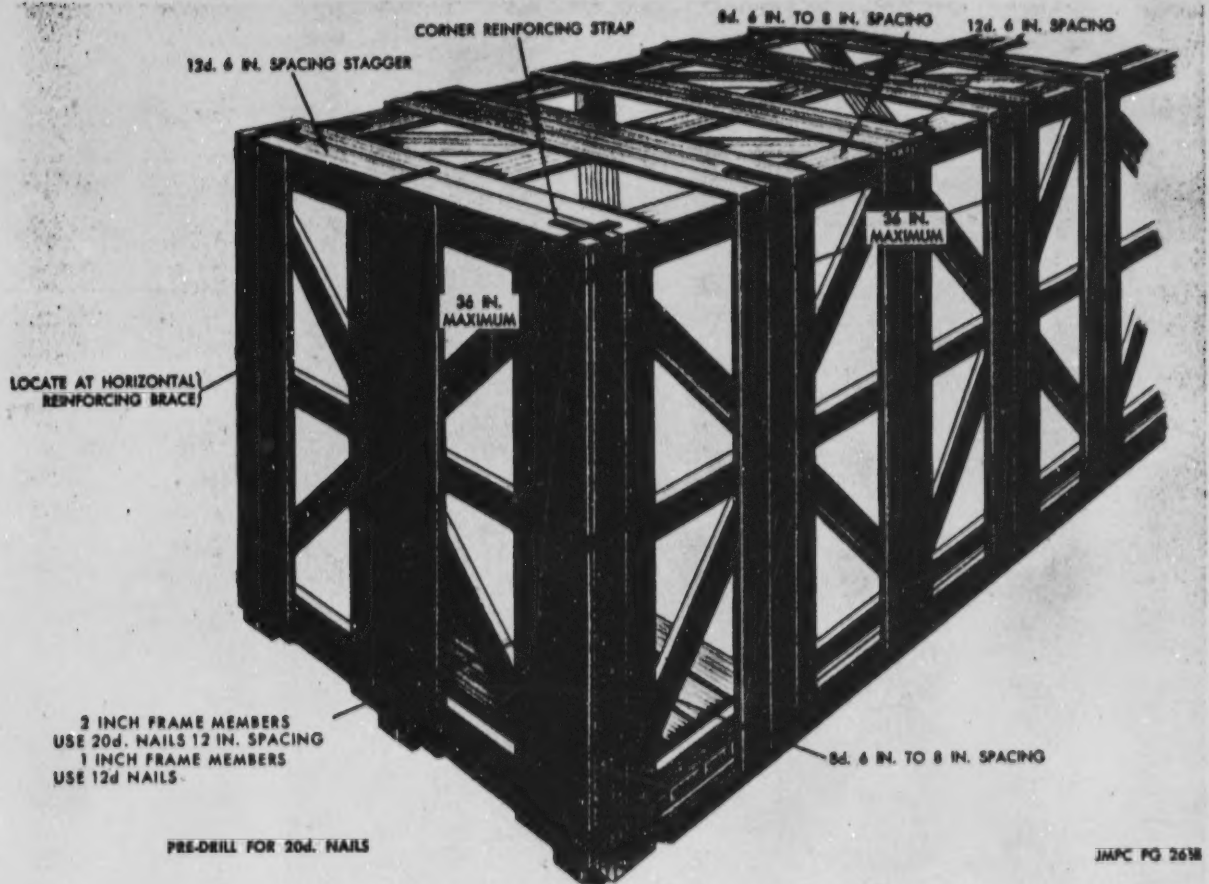


Figure 6-4. Assembly of open nailed crate (MIL-C-3774).

size, weight, and characteristics of the contents. Examples of special crates are illustrated in figure 6-7. The slotted angle crate (MIL-C-9897) is an example of a special metal crate which may be either open (Type I) or sheathed (Type II) with either plywood, paper overlaid veneer, or fiberboard (fig 6-8). It may be fabricated without skids (Style A), or with skid blocks or skids with rubbing strips (Style B). Both the open and sheathed Style A slotted angle crates are restricted to items not to exceed 500 pounds, with dimensions not to exceed 10 feet in length, 2½ feet in width, and 6 feet in height, except when a specified design has been approved by the contracting activity. Both the open and the sheathed Style B carry up to 3,000 pounds and are limited to not over 30 feet in length, 4 feet in width, and 7 feet in height (fig 6-8).

c. Criteria for Crate Design. Crates are selected instead of boxes for several reasons. The item may be too large to be shipped in a box. The weight of the item may exceed the weight limitations of a

box specification. The item may not require complete enclosure for protection, yet it may require crating to facilitate storage and handling. Crates provide better facilities for clearances, blocking, bracing, and anchoring of the item. To select the proper crate for the item or items to be packed, it is necessary to consider certain basic factors that may influence the selection.

(1) *Size and weight.* Basically, it is desirable to design a crate not to exceed 30 feet in length, 9 feet in width, and 10 feet in height, with a weight limitation not to exceed 11,200 pounds. This maximum size and weight is indicated because the length of 30 feet will permit lowering the crate through the average ship's hatch without excessive tilting. The 9-foot width and 10-foot height is designed for the average width and clearance limits for transporting by rail on a standard flat car. Taking the weight factor into consideration will permit ease of handling by the average ship's hoisting facilities.

(2) *Degree of protection.* To determine the

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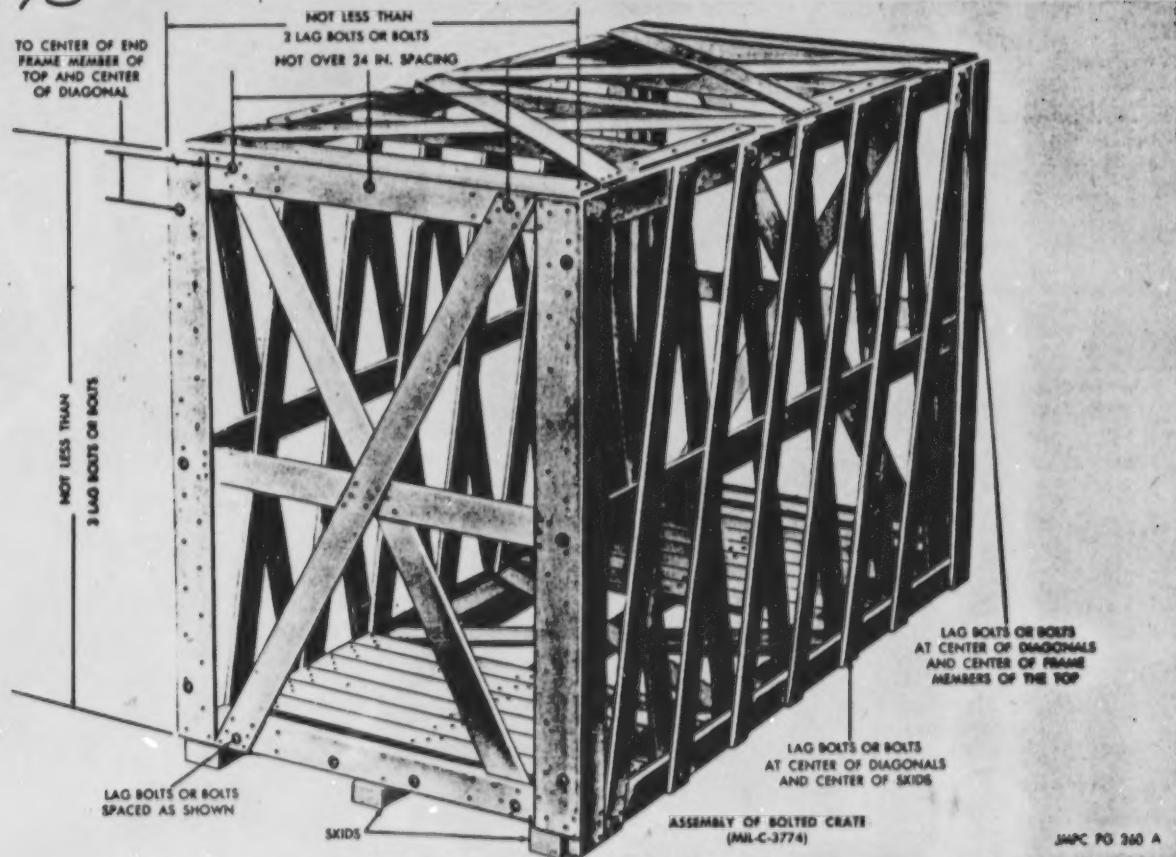


Figure 6-5. Assembly of Open Bolted Crate (MIL-C-3774).

degree of protection required for the contents, it is necessary to know the nature of the item and, if possible, the storage, handling, and shipping hazards to be encountered. If the item requires little protection from the elements, use an open crate. When the nature of the contents requires some protection from the elements, select an open crate and place an interior shroud over the contents or provide a type V, style B, covered, crate (fig 6-3). When the contents requires the maximum amount of protection, use a fully sheathed crate.

(3) *Degree of disassembly.* When determining the size, weight, shape, and strength, consideration should be given to partial disassembly of the item or its components to reduce the overall size of the crate. However, do not disassemble the item to the point where special tools or personnel are needed to reassemble it.

(4) *Weight distribution.* In designing crates over 5 feet in length, weight distribution becomes an important factor. Whenever possible, the center of gravity of the contents should coincide with

the geometrical center (center of balance) of the loaded crate.

(5) *Anchoring of the contents.* A thorough study of the contents should be made in order to insure that provisions are made for anchoring the contents within the crate to prevent damage during handling and shipment. When necessary, use cushioning and padding at points on the item where blocking, bracing, or strapping is used to prevent movement. Bolts, steel strapping, iron bands, rods and lumber holdowns are acceptable methods for anchoring and supporting the contents (fig 6-9). Some items are designed with packing and shipping in mind and are provided with hold-down features. If the item does not have these characteristics, utilize the stronger areas of the item for anchoring.

(6) *Clearance.* Normally, a minimum of one-inch clearance is required between the contents and the nearest framing member of the sides, ends, and top. This clearance allows for the distortion and vibration to which the crate may be

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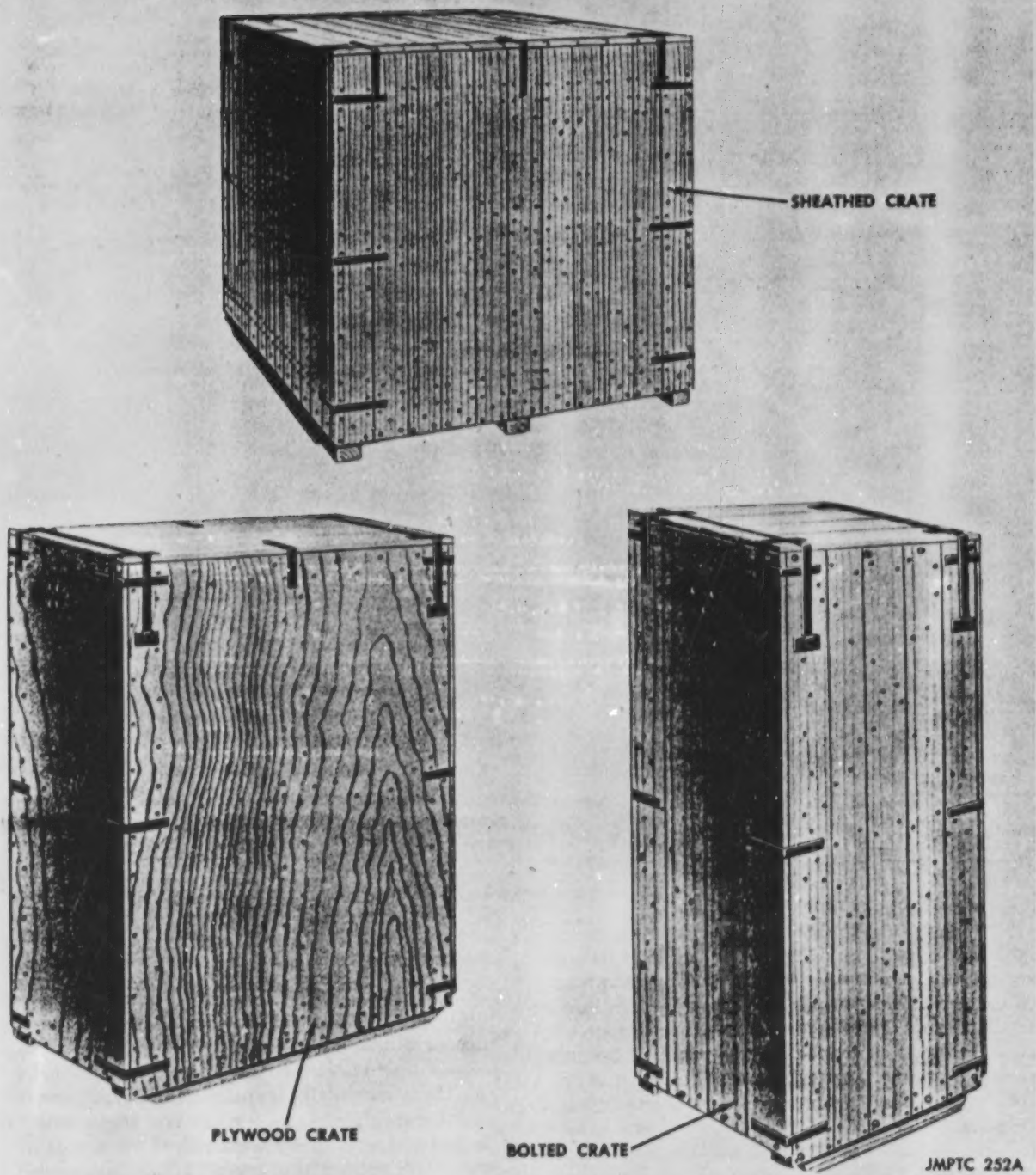
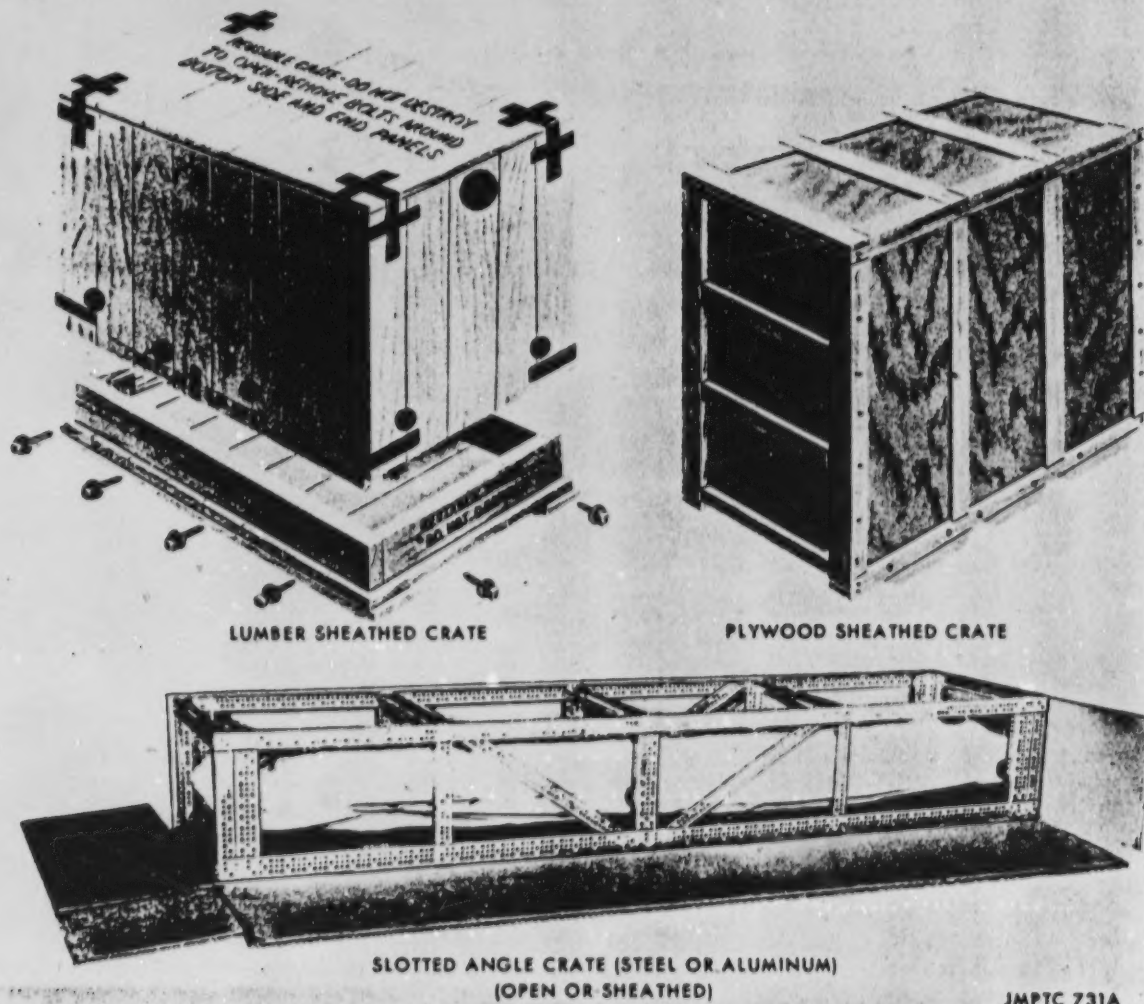


Figure 6-8. Sheathed crates.

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Figures 6-7. Special use crates.

subjected during rough handling and transit. Items that are fragile in nature, or items within floating bag barriers (submethods IIa and IA-16) require from 2 to 4 inches of clearance (chap 3, vol I). Additional clearance may be required for shock mounted items. Through careful design, it is often possible to allow protruding points of the item to extend between the joists, or the joists may be spaced, within specified limits, to accommodate these protrusions.

(7) *Types of bases.* The selection of a skid or a sill base will depend on the physical characteristics of the item to be crated.

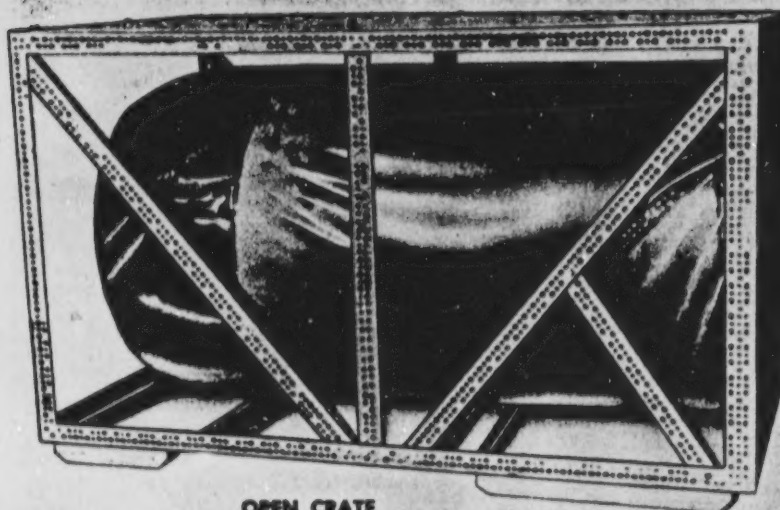
(a) *Sill bases.* Sill bases (fig 6-10) are designed for items that can be supported above their lowest point. Examples are transmission housing,

engines and vehicles with brake drums projecting below the frame or axles.

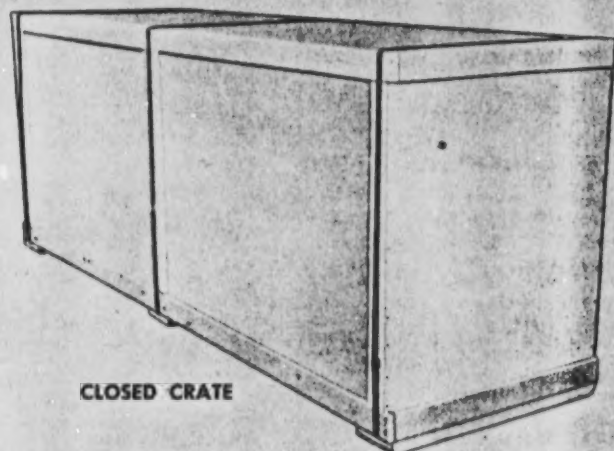
(b) *Skid bases.* Skid bases are designed to accommodate loads that can be supported on their lowest portion, or items that are made to rest flat on their bases. Skid-type bases are preferred in most cases; however, when the item must be supported above its lowest point, the use of a sill base will reduce the overall height of the crate. Savings in height should be more than 6 inches before substituting a sill base for a skid base (fig 6-11).

d. *Engineering Factors in Crate Design.* A crate is an engineered container. The use of sound engineering principles and actual tests of crates

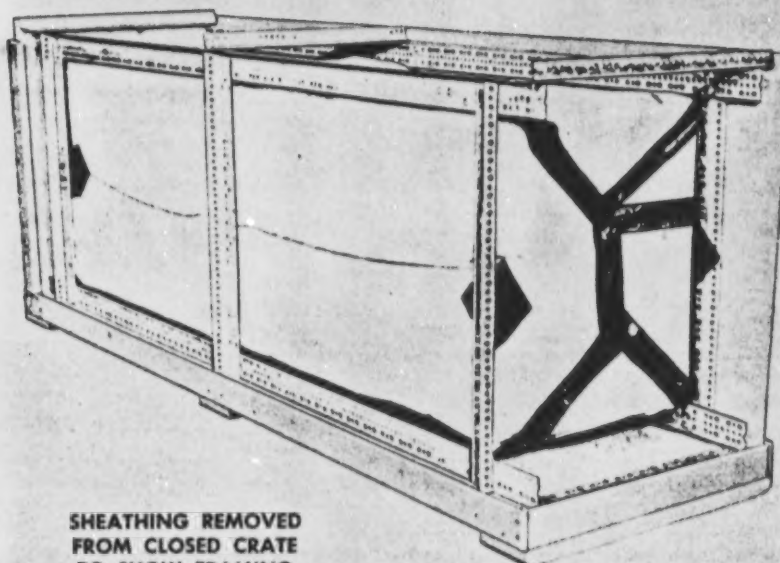
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OPEN CRATE



CLOSED CRATE

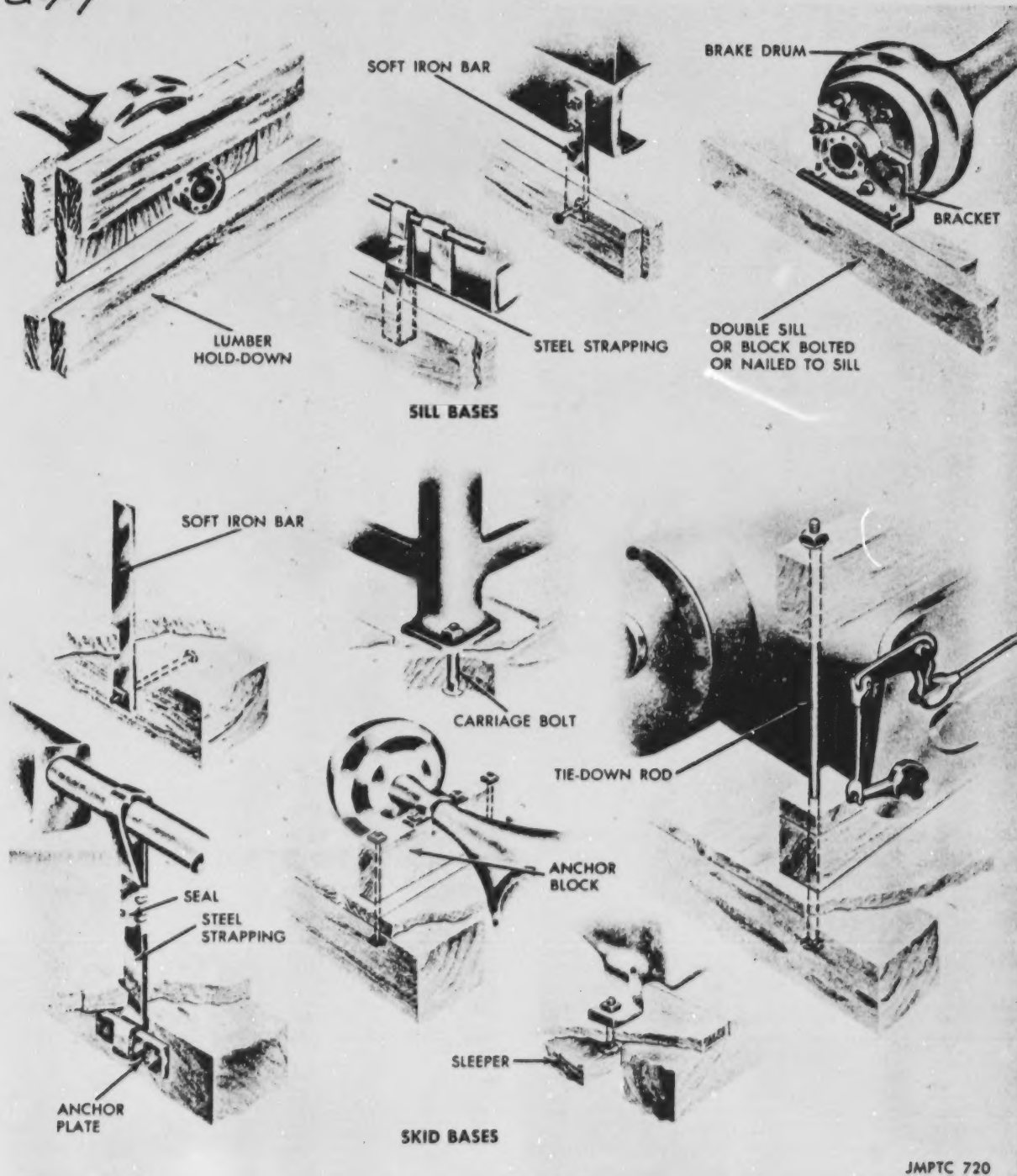


SHEATHING REMOVED
FROM CLOSED CRATE
TO SHOW FRAMING

JMPTC 709

Figure 6-8. Slotted angle crates.

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JMPTC 720

Figure 6-9. Methods of anchoring contents in crates.

with contents has resulted in the following design requirements:

(1) *Tops*. The top of a sheathed crate is designed to carry a uniform, well-distributed, super-

imposed load of 50 pounds per square foot. Top loading plus the span or width of the crate will determine the kind of top and the size of joist required to transfer the load to the sides. Top load-

Note. All lumber dimensions referenced in this section are nominal. Actual dimensions are so indicated when actual sizes are required.

Table 6-1. Minimum Thickness and Width of Lumber

Thickness in inches (smaller dimension)		Width in inches (larger dimension)	
Nominal size	Minimum (actual)	Nominal size	Minimum (actual)
1	3/4	2	1-1/2
		3	2-1/2
2	1-1/2	4	3-1/2
3	2-1/2	5	4-1/2
4	3-1/2	6	5-1/2
5	4-1/2	8	7-1/4
6	5-1/2	10	9-1/4
7	6-1/2	12	11-1/4

b. *Plywood (NN-P-530)*. Plywood is used in crate construction for sheathing, for nonload bearing flooring, for tops, and gusset plates. While plywood is usually more expensive than lumber, it requires no diagonals or crate liner material when used as sheathing, and a lighter, more economical crate may result from its use. Tests have shown that plywood is actually stronger than lumber, the dimensions being the same. When using plywood, select the standard size sheet stock that conforms closest to the crate dimensions, otherwise waste of material will result. The type of plywood selected will be on the basis of its intended use. Where prolonged exposure to the elements or attack by micro-organisms (mold, fungi, etc.) is expected, materials must be selected that will withstand the extreme conditions.

c. *Nails (FF-N-105)*. Nails are used in the fabrication of the components for both nailed and bolted crates. They are also used in the assembly of nailed crates. The preferred types of nails used for crate assembly are the sinker, corker, or common. If these nails are not available, coolers or standard box nails may be used. Nails used for fastening plywood should be 14-gage with heads no less than 7/32-inch diameter (fig 3-4).

d. *Staples (FF-N-105)*. Staples are sometimes used to fasten plywood sheathing to the framing members. When used for this purpose, staples should be made of 16-gage wire with a crown not less than one-half inch.

e. *Bolts, Nuts, and Washers*. Many types of bolts are used in crate construction. The most common types used are standard steel carriage, step, and machine bolts (fig 6-13). Bolt holes should be drilled the same size as the shank of the bolt. Plain washers should be used under the heads of the machine bolts and under all nuts. Special

holding plates have been designed for use under the heads of square shank bolts to prevent turning. The use of plates is not mandatory. Counter-sinking of bolt heads is prohibited. The bolt threads projecting beyond the nut after tightening should be painted with P-1 or P-19 (hard drying preservative), unthinned lead paint or other similar material to prevent loosening.

f. *Lag Bolts (FF-B-561)*. Lag bolts are sometimes referred to as "lag screws." There are three types of lag bolts—Type I, Gimlet Point, Square Head; Type II, Cone Point, Square Head; and Type III, Cone Point, Square Head, Fetter Drive (fig 6-13). Types I and II have a standard V-type thread and Type III has a buttress type of thread. Lag bolts are used to assemble the sides, ends, and tops of demountable crates. These bolts are prohibited for use as holddowns or to tie the headers and the floorboards to the skids. When using lag bolts for assembly, drill the lead hole to the same diameter as the shank, although the threaded portion may be larger than the shank. The size of the lead hole for the threaded portion will depend upon the group of wood used. When using lag bolts in soft woods, make smaller lead holes. Use plain washers under the heads and tighten firmly against the washer (table 6-2).

Note. Lag bolts should never be driven with a hammer. When power wrench is used, care must be taken that the bolts are not overdriven.

Table 6-2. Application of Lag Bolts

Diameter of threaded portion of lag bolts	Diameter of lead hole	
	Groups I, II and III wood	Group IV wood
Inch	Inch	Inch
1/4	3/16	3/16
3/8	1/4	5/16
1/2	3/8	3/8
5/8	3/8	1/2
3/4	1/2	5/8

g. *Nut Sleeve Assembly*. A nut sleeve assembly, as illustrated in figure 6-14, may be used as an alternate for lag bolts in demountable crates. These bolts must be the same size as the fasteners they replace and are spaced the same distance apart.

h. *Metal Strapping (QQ-S-781)*. Metal strapping is used for reinforcing crate corners, sill bases, securing tops, as lag bolts reinforcing straps for demountable crates, and for strengthening sill and load bearing headers for sill-type bases. It is also used to reinforce crate corners and the tops of open crates. Metal straps used for this purpose

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shall be Class 1 Type 1 or II, and not less than $\frac{3}{4}$ x 0.028-inch (fig 6-15).

(1) *Corner straps.* Metal strapping used for reinforcing tops, corners, and sill-type bases is usually annealed and predrilled for ease of application. This type of strapping is used on all nailed crates and on bolted crates with net loads over 3,000 pounds. The legs of the corner straps are usually 8 inches in length. They are nailed to the frame members with a minimum of three galvanized roofing nails, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches long. The straps are spaced no more than 36 inches apart.

(2) *Tension straps.* Tension straps are used to secure the top to the sides of the crate. They are secured to the sides of the crate by anchor plates, which are nailed to the frame members. The straps are drawn tight with a tensioning device and held in tension with two seals. Tension straps are spaced no more than 6 feet apart.

(3) *Lag bolt reinforcing straps.* This strap is fabricated from galvanized steel and is used on the side and end panels of many demountable crates to prevent the lag screws from tearing through the sheathing as the crate is lifted. The strapping material is prepunched or predrilled. Lag bolts three-eighths inch in length require $1\frac{1}{4}$ x 0.035-inch straps. For $\frac{1}{2}$ -inch and $\frac{3}{8}$ -inch lag screws, 2 x 0.050-inch straps are needed. Nail these straps to the lower inner face of the sheathing between the lower edge of the bottom frame member and the bottom frame member and the bottom of the sheathing. Locate them to coincide with the center of the skids and headers. Use clout or similar nails to secure the strapping. Space the nails a maximum of 2 inches on center and clinch at least three-fourths of an inch (fig 6-16).

(4) *Metal hanger.* Metal hangers are used for reinforcing joists of tops, load bearing headers, and intermediate sills on sill-type bases. Hangers are fabricated from steel straps $1\frac{1}{4}$ x 0.035-inch. The strapping material is prepunched or predrilled. When used to reinforce load bearing headers or intermediate sills, eightpenny nails are used to secure straps in place, followed by driving from two to four twentypenny nails into the end-grain of the holding member (fig 6-17).

(5) *Sill base straps.* In addition to the straps applied to other areas of the crate, sill bases must be reinforced with $\frac{3}{4}$ x 0.028-inch metal straps (fig 6-18). Use a minimum of three galvanized roofing nails $1\frac{1}{4}$ to $1\frac{1}{2}$ -inch long in each leg of the strap. Locate all nails to penetrate a framing member.

i. *Waterproof Liners and Shrouds (PPP-B-1055).* Waterproof barrier material is made by laminat-

ing layers of kraft paper with asphalt. Seven different classes of material may be used for crate liners. The most common classes used are E-1, E-2, and C-2. This material, when used as a liner, is placed horizontally between the sheathing and the frame members of the sides and ends. If more than one width of material is required, use a minimum of 4-inch shingle lap for proper drainage. The barrier should cover the entire framed area. When vertical joints are required, the 4-inch lap will be located at a vertical member. Liners are not required for plywood sheathed crates. Interior shrouds, large bags, or envelopes fabricated from waterproof barrier material are used in open crates to cover items which require additional protection. All sharp projections of the item should be cushioned or padded to prevent puncturing the material. The class of material to use is optional, although the most common class is E-2. All joints in the material are made by using MMM-A-260 adhesive. Shrouds should hang free of the item to provide proper ventilation and should extend to within 6 inches of the bottom of crate. Material conforming to Specification MIL-B-13239 may also be used for interior shrouds. This material is constructed of polyethylene coated kraft and does not contain asphalt. It should be used to protect items under severe climatic conditions where asphalt-laminated barriers would not suffice (fig 6-19 and 6-20).

j. *Roofing Felt (SS-R-501).* Roofing felt is used in the construction of tops for sheathed crates. This material should have a smooth uncoated surface with a minimum weight of 45 pounds per square (a square is an area of 10 feet by 10 feet, or 100 square feet). The material is placed between the outer lumber sheathing and inner plywood sheathing of the top as illustrated in figure 6-59. When a joint is required, overlap the felt 4 inches and seal with an asphaltic mastic compound.

k. *Screens and Ventilators.* Screens are fabricated from heavy rust-resisting wire of $\frac{1}{4}$ or $\frac{3}{8}$ -inch mesh and used over ventilating and drainage holes to prevent entry of birds, insects, rodents, or other animals. Ventilators fabricated from metal are sometimes used over ventilating holes. Some of the most common methods are illustrated in figure 6-49.

l. *Inspection Doors.* When inspection doors are required, they are made without cutting into the framing members. Doors are fabricated from the same material as the sheathing. Hinge at the top and fasten with lag bolts or wood screws at the sides and bottom (fig 6-21). Make cleats and stops from 1-inch material. Drill holes through the door

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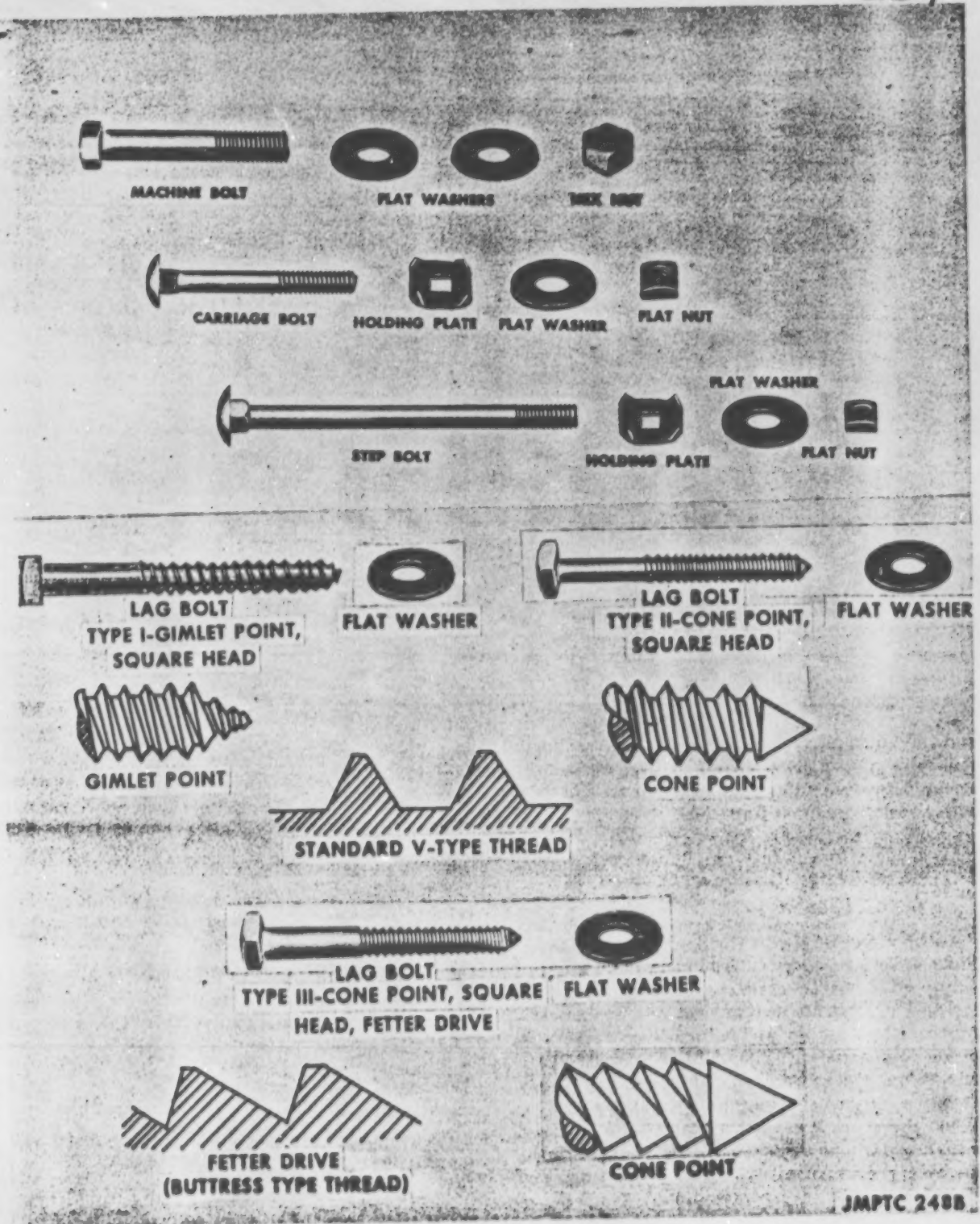


Figure 6-13. Bolts, screws, and accessories.

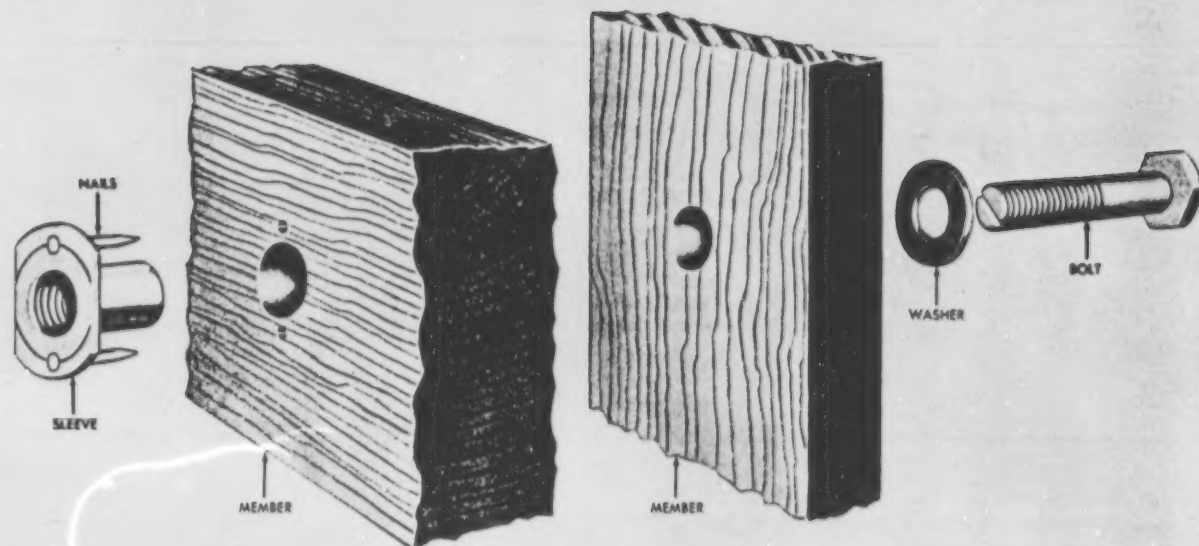


Figure 6-14. Nut sleeve assembly.

and the adjacent frame member to provide for a seal wire and lead seal bearing the inspector's stamp. The size and location of the doors will vary with the nature of the item.

6-3. Wood Crates, Open and Covered, PPP-C-650 (General)

a. Crate Design. Open wood crates described in this section are designed for general use and are employed for both domestic and oversea shipments. Only items which are not readily damaged from outside forces and which require limited protection should be shipped in open crates. Usually, items which are designed for outdoor use or of rugged construction are shipped in open crates. When there are a variety of items to be shipped, each crate will be designed for each item with the necessary clearance for blocking, bracing, and cushioning.

b. Classification. Crates fabricated or procured under Specification PPP-C-650 are classified on the basis of weight, size, and construction features, as indicated in table 6-3.

c. Material Requirements.

(1) *Wood.* The requirements for lumber will be in accordance with MIL-STD-731 with this exception. Divergence of grain (cross-grain) should not exceed one inch in ten inches of length. Plywood, when used, will conform to NN-P-530.

(2) *Fasteners.* Nails, staples, strapping, lag screws, etc., treated in paragraph 6-2c through h will be used as applicable.

(3) *Waterproofing materials* (para 6-2i).

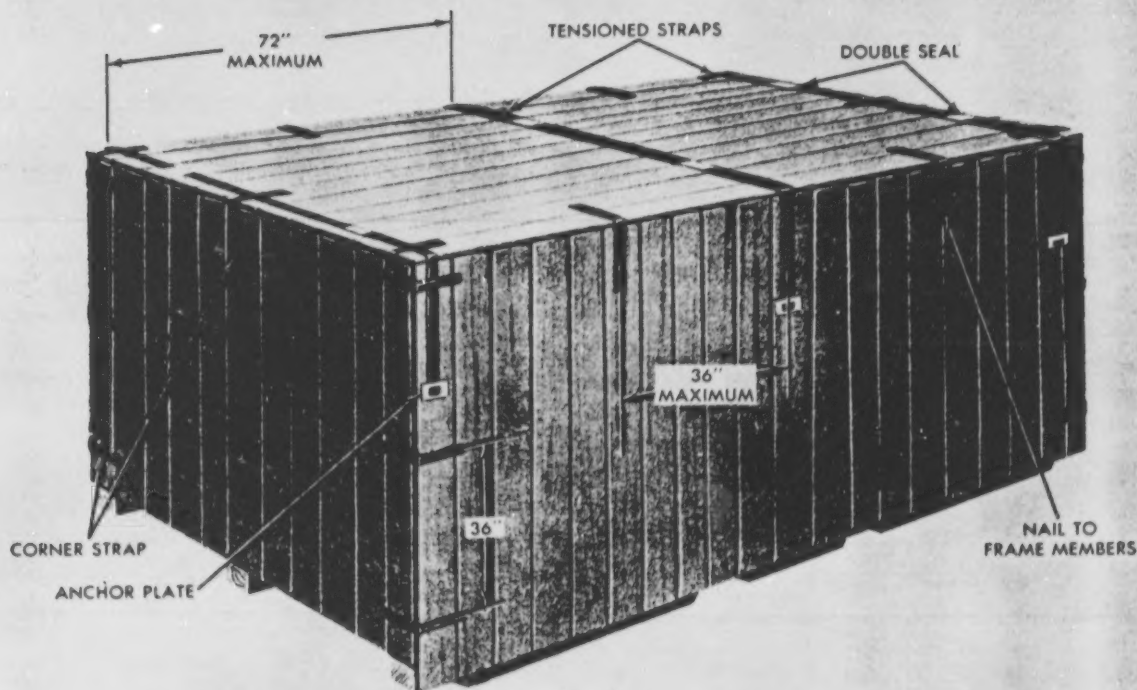
6-4. Type I, Style A—Heavy Duty Crate (PPP-C-650)

a. Design Requirements (fig 6-23).

(1) *Base Assembly.*

(a) *Skids.* The base is framed on 2 x 4-inch longitudinal skids.

(b) *Rubbing strips.* Rubbing strips are 2 x 4-inch material beveled full depth at an angle of 45° at each end. Provisions are made for handling by slings or forklift trucks. Forklift truck openings are 12 inches in length, 28 inches center to center, and positioned to straddle the center of balance of



NOTE:
STRAPPING IS REQUIRED FOR ALL NAILED CRATES
(FOR BOLTED CRATES WITH NET LOADS OVER 3000 LBS.,
USE CORNER STRAPS ONLY)

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Figure 6-15. Tension and corner strapping.

the loaded crate. The center piece of the rubbing strip (located under the center of balance) is no less than 16 inches long. Sling openings (located at each end of the rubbing strips) are a minimum of 4 inches and preferably 8 inches in length. On short crates, forklift truck openings may serve as sling openings when the crate length does not permit both or when the crate is less than 5 feet long.

(c) *Load bearing members.* Determine the thickness of the load bearing floor members by computing the concentrated load of the item on each linear inch of floorboard width it occupies and the distance between the outside skids of the crate. Figure 6-22 illustrates the procedure for determining thickness of load bearing floorboard members and use of table.

(d) *End floor members.* End floor members or headers, located at each end of the skids, are the same width and thickness as the skids. If used as load bearing members, determine their size from table 6-4, adding 2 inches to the width. Bolt these members to the skids with $\frac{3}{8}$ -inch carriage bolts.

(e) *Diagonals.* Diagonals are 1 x 4-inch lumber. The angle between the skid and the diagonal should be neither less than 30 degrees nor more than 60 degrees.

(2) *End assembly.* Each end assembly consists of two vertical struts, an upper and a lower edge member, and a diagonal. All members of the end assembly are 1 x 4-inch material.

(3) *Side assembly.* Each side assembly consists of members that are identical to the ends.

Table 6-3. Classification of PPP-C-650 Crates

Type	Maximum net load	Maximum inside dimensions		
		Length	Width	Height
I	Pounds 250	Feet 4	Feet 3	Feet 3
II	500	12	4	2
III		No style A		
IV	1,000	6	4	4
V	2,500	12	6	6

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Table 6-3—Continued

Style B—Light duty				
Type	Maximum net load	Maximum inside dimensions		
		Length	Width	Height
I	Pounds 200	Feet 4	Feet 3	Feet 3
II ^a	500	12	4	2
III	No load or size restrictions except as limited by handling methods. Crates are designed for long, self supporting items such as structural sections.			
IV	No style B			
V ^a	4,000	32	6	10

^a (a) Items such as ladders, tubing, and extrusions weighing less than 200 pounds and which are less than 30 feet long, less than 3 feet wide, and less than 2 feet high may be packed in type II crates.

(b) Items such as plywood, gypsum board, and sheet metal which require no blocking, bracing, or cushioning may be packed in type II crates up to a maximum gross weight of 1,000 pounds.

^a Type V, style A crates shall be classified further as follows: Class 1—nailed; class 2—demountable. Type V, style B crates may be open or covered.

(4) *Top assembly.* The top consists of diagonals and longitudinal and lateral members, all of which are 1 x 4-inch lumber. Longitudinal members must coincide with the vertical struts of the end. Lateral members must coincide with the vertical struts of the side panels. End lateral members are adjacent to the upper edge members of the end panels. This makes a 3-way interlocking corner.

b. Fabrication of Style A.

(1) Base assembly.

(a) Skids and end floor members.

1. Place the skids in a temporary jig, on a nailing table, or on a hard flat surface.

2. Position the end floor members (headers) with the wide faces down at right angles to the length of the skids.

3. Set the floor members back from the end of the skids a distance equal to the thickness of the lower edge member of the end panel.

4. Place the ends of end floor members back from the outer edge of the skids a distance equal to the thickness of the lower edge member of the side panel.

5. Attach the end floor members to the skids with one 3/8-inch carriage bolt, including a nut and washer.

(b) Diagonal members.

1. Place a 1 x 4-inch diagonal member between the load bearing members at an angle not less than 30 degrees nor more than 60 degrees from the outside skids.

2. Use twelvepenny cement-coated nails to secure the diagonals to the skids. Three nails are required.

(c) Rubbing strips.

1. Place 2 x 4-inch rubbing strips on all skids parallel to the length of the skids.

2. Provide 4- to 8-inch openings at each end of the skids for sling notches, and 12-inch openings on 28-inch centers (positioned to straddle the center of balance) for forklift entry.

Table 6-4. Thickness of Load Bearing Floorboards for Open and Sheathed Crates¹

Distance between outside skids	Thickness of load bearing floorboards (inches) ²					
	1	2	3	4	5	6
Inches	Allowable load per inch of floorboard width (lbs.)					
12	47	220	574	1,095	2,520	4,682
18	32	147	382	731	1,678	3,118
24	24	110	287	548	1,260	2,341
30	19	88	229	438	1,008	1,870
36	16	73	192	365	841	1,562
42	14	63	164	313	720	1,339
48	12	55	144	274	630	1,170
54	11	49	127	243	560	1,040
60	9	44	115	219	504	936
66	9	40	104	199	456	852
72	8	37	96	182	420	781
78	7	34	88	168	388	721
84	7	31	82	156	360	669
90	6	29	77	146	336	625
96	6	27	72	137	315	585
102	6	26	67	129	296	550
108	5	24	64	122	280	530
114	5	23	60	115	265	492
120	5	22	57	110	252	468

¹ Table is based on groups I and II woods. If group III or IV woods are used, the above allowable loads may be increased 20 percent.

² Wood thickness shown are nominal thicknesses.

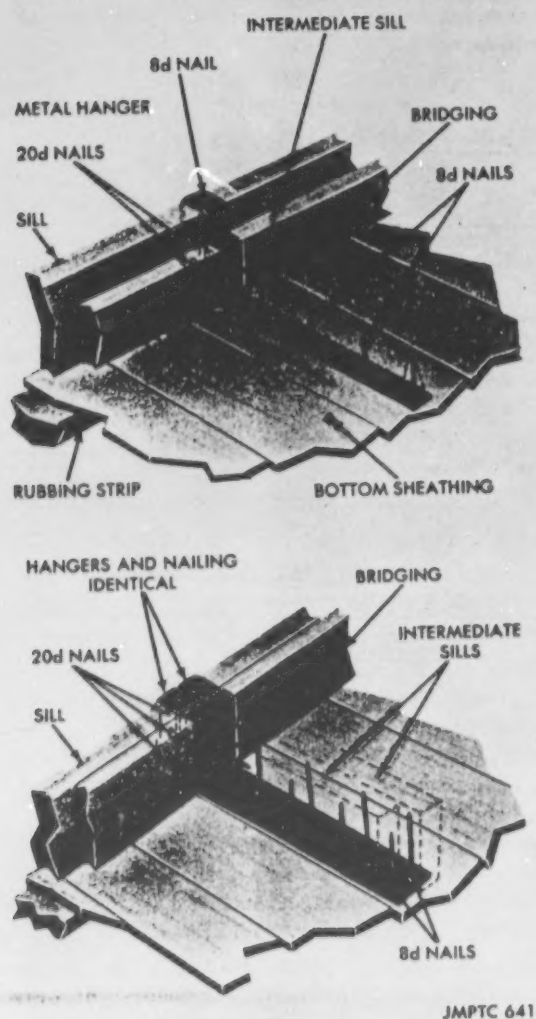


Figure 6-16. Lag bolt reinforcing strap.

3. The piece under the center of balance should not be less than 16 inches long.

4. Secure rubbing strips with two rows of twelpenny cement-coated or etched nails spaced 18 inches apart.

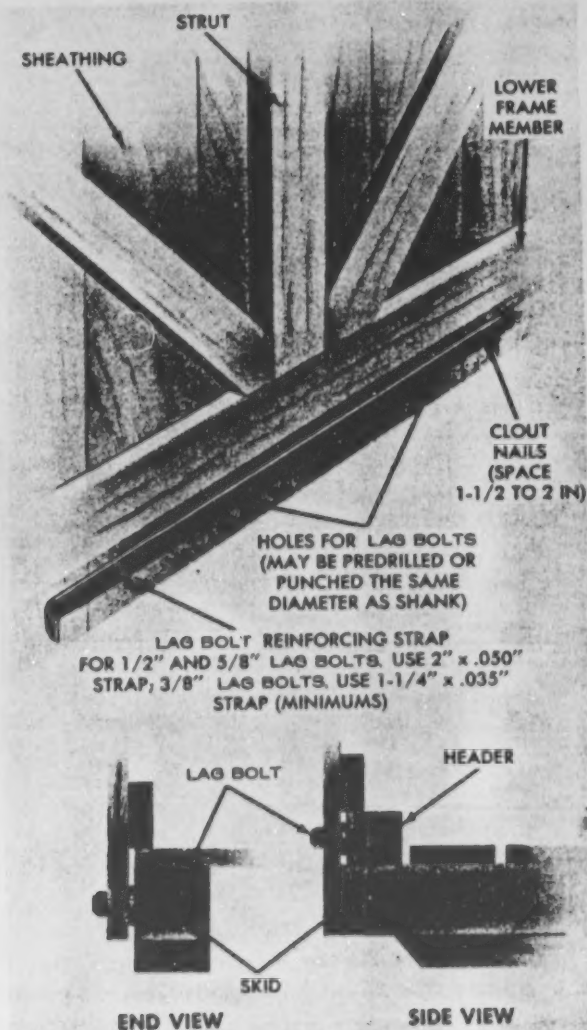
(2) End assembly.

(a) Vertical struts, upper and lower end members.

1. Place 1 x 4-inch vertical struts in a temporary jig, on a nailing table, or on any flat surface.

2. Position the upper and lower edge members on top of the vertical struts, at right angles.

3. Extend the top edge of the upper edge member over the lower ends of the vertical struts



NOTE: LOCATE STRAPS ON SIDES TO CENTER ON SKID DEPTH; ON ENDS TO CENTER ON HEADERS

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Figure 6-17. Use of metal hangers.

a distance equal to the thickness of the member of the top.

4. Extend the lower edge of the lower edge member beyond the ends of the vertical struts a distance equal to the thickness of the end floor member of the base.

5. Extend the ends of the lower edge member beyond the sides of the vertical struts a distance equal to the thickness of the lower edge member of the side.

6. Use four sevenpenny bright nails at each joint to secure the upper and lower edge members to the vertical struts. Clinch all the nails.

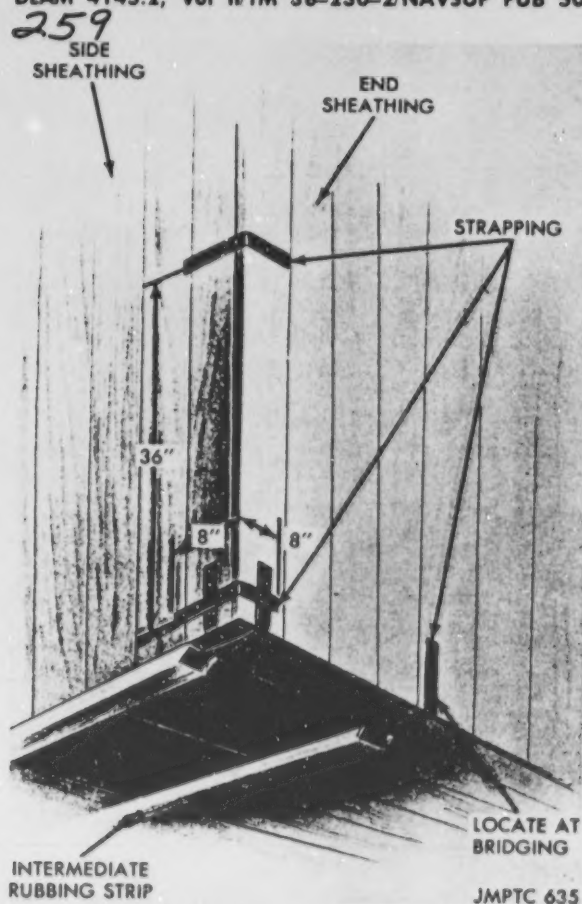


Figure 6-18. Application of strapping (sill base).

(b) End diagonal members.

1. Place the ends of the 1 x 4-inch diagonals against the lower edge of the upper edge member and against the upper edge of the lower edge member.

2. Extend the ends over the vertical struts a distance equal to the thickness of the vertical strut of the side panel.

3. Secure the diagonal members to the vertical struts using sevenpenny nails. Be sure the nails are clinched. Three nails are required at each joint (fig 6-54).

(3) Side assembly.

(a) Longitudinal and lateral members.

1. Place 1 x 4-inch vertical struts in a temporary jig, on a nailing table, or on a flat surface.

2. Place the 1 x 4-inch upper and lower edge members on the top of the vertical struts.

3. Extend the ends of the vertical struts beyond the upper edge of the upper edge member of the side, a distance equal to the thickness of the longitudinal member of the top, and below the

lower edge of the lower edge member of the side, a distance equal to the thickness of the skid and floor members.

4. Secure the upper and lower edge members to the vertical struts with clinched fivepenny bright nails (fig 6-54).

(b) Diagonal members.

1. Position the 1 x 4-inch diagonal members between the vertical struts so that the ends project over the upper edge member a distance equal to the thickness of the longitudinal members of the top.

2. Extend the diagonals over the lower edge members a distance equal to the thickness of floor members and skids.

3. Secure the diagonals to the upper and lower edge members with fivepenny nails. Four clinched nails are required at each joint (fig 6-54).

(4) Top assembly.

(a) Longitudinal and lateral members.

1. Position the 1 x 4-inch longitudinal members in a temporary jig, on a nailing table, or on a flat surface.

2. Place the 2 x 4-inch lateral members on top of the longitudinal members, at right angles to the longitudinal members.

3. Set back the ends of the lateral members from the edges of the longitudinal members a distance equal to the thickness of the upper edge member of the side, and in from the ends of longitudinal members, a distance equal to the thickness of the upper edge members of the end.

4. Secure the lateral members to the longitudinal members with four clinched eightpenny nails (fig 6-54).

(b) Diagonal members.

1. Place the 1 x 4-inch diagonals between the lateral members, the ends flush with the outside edge of the longitudinal members, at an angle of not more than 60 degrees or less than 30 degrees to the longitudinal member.

2. Secure the diagonals to the longitudinal members with four clinched fivepenny nails.

c. Assembly of Style A.

(1) Side panels to the base.

(a) Position the side panel in line with the base, with the lower edge member resting on the floorboards.

(b) Nail the overlap of the vertical struts and diagonals to the skids using three eightpenny cement-coated nails at each joint (vertical struts and diagonals).

(2) End panels to the side panels.

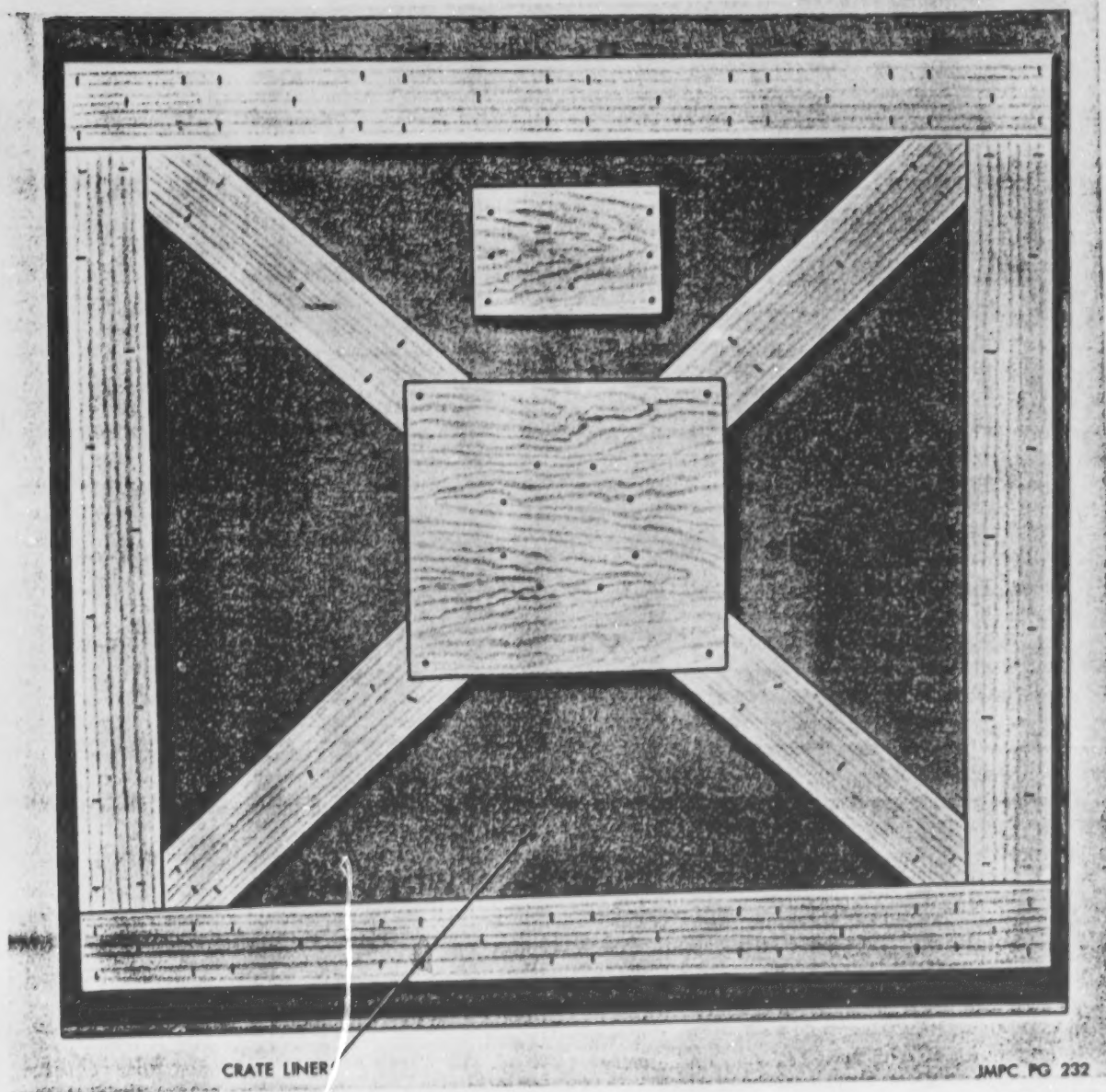


Figure 6-19. Crate liner.

(a) Position the end panels so that the vertical struts fit between the vertical struts of the side panels, with the lower edge members of the end resting on the skids.

(b) Nail the overlap of the lower edge member of the end panel to the end floor member with one row of eightpenny coated sinker nails. Space the nails 6 to 8 inches apart in a staggered pattern.

(3) *Side panels to the end panels.*

(a) Align the vertical strut of the side with the vertical strut of the end.

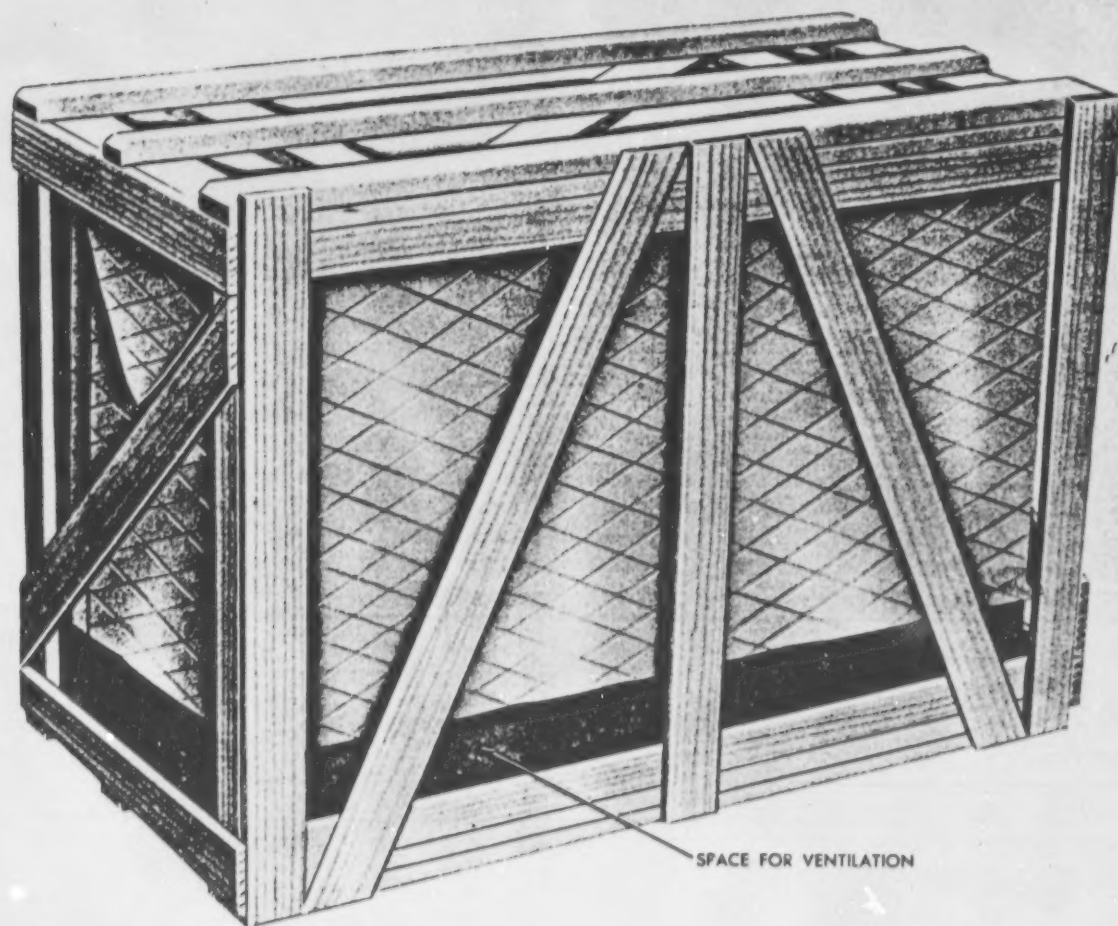
(b) Nail together with eightpenny coated sinker nails in one row, spaced 8 to 10 inches apart.

(4) *Top to the side and end panels.*

(a) Position the longitudinal members of the top to rest on the upper edge members of the side, and the lateral members to rest on the upper edge members of the end.

(b) Use three eightpenny coated sinker nails at each joint on the side panels. Nail the overlap of the vertical struts and the diagonals of the

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Figure 6-20. Interior shroud.

sides and ends to the longitudinal and lateral members of the top.

(c) Nail the upper edge member of the end panel to the lateral members of the top with one row of eightpenny nails spaced 8 to 10 inches apart.

(5) *Corner straps.*

(a) Fabricate the corner straps from $\frac{3}{4}$ x 0.028-inch nail-on metal strapping. Cut each strap approximately 11 inches long.

(b) Bend the straps in the center at a 90 degree angle to form two legs approximately $5\frac{1}{2}$ inches on each leg.

(c) Use corner straps at each end of the eight corners and at the intermediate struts when required.

(d) Apply and secure the straps, centering all of them on the framing members (fig 6-1).

1. Apply the first strap from the end to the side, the second from the end to the top or base, and the third from the side to the top or base.

2. When intermediate struts are required, apply one strap from the top or base to the side.

3. Nail each leg of the strap with three sixpenny nails spaced $1\frac{1}{2}$ inches apart.

6-5. Type I, Style B—Light Duty Crate (PPP-C-650)

a. *Design Requirements.* The size limitations are as specified in table 6-3.

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6-6. Type II, Style A—Heavy Duty Crate (PPP-C-650)

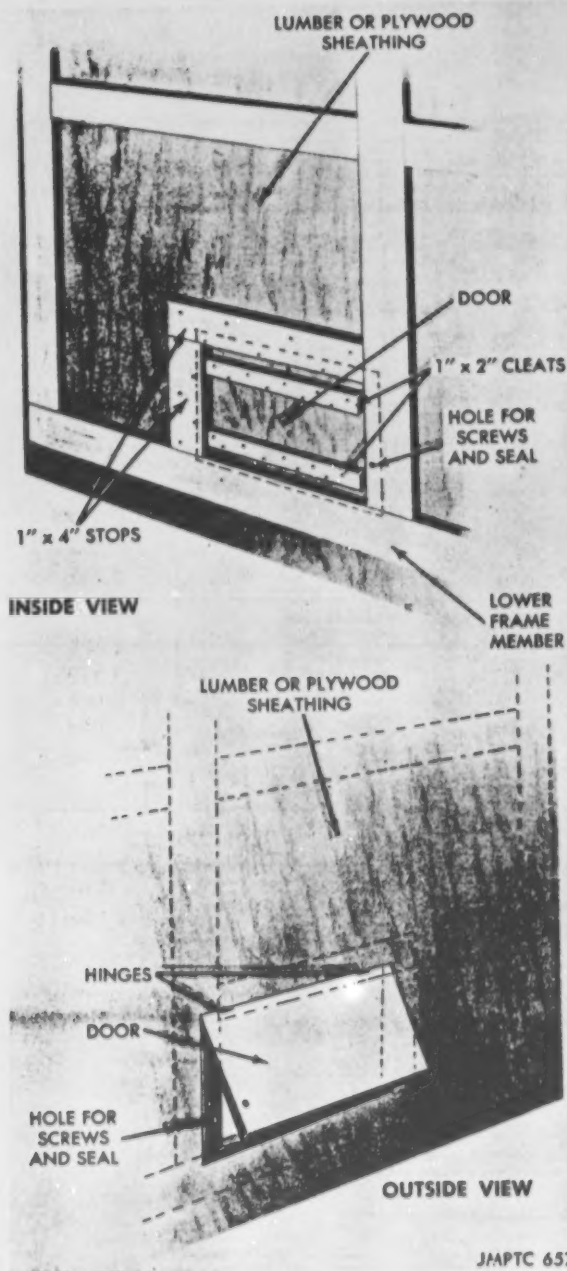


Figure 6-21. Crate inspection door.

b. Frame Members Sizes. All frame members shall be one by three inches in size for net loads up to 100 pounds and one by four inches in size for loads between 100 and 200 pounds.

c. Design Requirements. Crate shall be as shown in figure 6-24. Diagonals, struts, cross members and longitudinal members are nailed with two eightpenny sinker nails in each end of each member.

a. Design Requirements (fig 6-25). The Style A crate is either partially lumber sheathed, or partially plywood sheathed. This style may be fabricated of all lumber construction, cleated plywood construction, or a combination of lumber ends and plywood sides.

(1) **Ends.** The ends are constructed of cleated plywood or lumber. Determine the sizes and thickness of material for the ends from table 6-5, based upon the maximum net load of contents.

(2) **Lumber sides.** The sides may be constructed of lumber or cleated plywood. When lumber is used, the sides are constructed of not more than three pieces for heights of 15 inches, two pieces for heights between 7½ and 15 inches, and one piece for heights of 7½ inches or less. Full length lumber is required for crates up to 14 feet; over 14 feet, two pieces of lumber of equal lengths may be used, provided they are butt joined at an intermediate batten. The thickness of lumber for the sides is based upon the maximum net load of contents as specified in table 6-6.

(a) **Battens.** Battens for lumber sides composed of two or more pieces are the same thickness and width as the top and bottom cross members.

1. Extend the battens the full depth of the sides and fasten to the inside surface of the sides.

2. Place the battens or cleats of the sides to coincide with the crossmembers of the top and space not more than 36 inches apart.

(b) **Diagonals and crossmembers.**

1. Use 1 x 4-inch members on crates up to 30 inches wide. Use 1 x 6-inch members on crates over 30 inches wide.

2. Space the crossmembers of the top and bottom not more than 36 inches apart and in line with the battens or cleats of the sides. Place the diagonals of the top and bottom in reverse direction of each other.

3. The angle of the diagonals to the side is not more than 60 degrees nor less than 30 degrees. The ideal angle is 45 degrees.

(c) **Plywood sides.** When plywood is used, the sides are constructed of a single width. Use a full length of plywood for crates up to 8 feet long; over 8 feet, two pieces may be used, provided they are butt joined at an intermediate batten. Space cleats not more than 36 inches apart. For sizes of materials, see table 6-6.

b. Fabrication of Style A.

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ALLOWABLE LOAD PER INCH OF FLOORBOARD WIDTH OF GROUPS I AND II WOODS

LENGTH BETWEEN OUTSIDE SKIDS (IN.)	THICKNESS OF LOAD BEARING FLOORBOARDS (IN.)				
	1 pound	3 pounds	4 pounds	6 pounds	8 pounds
12	47	574	1,095	2,520	4,682
18	32		731	1,678	3,118
24	24		548	1,260	2,341
30	19		438	1,008	1,870
36	16		365	841	1,562
42	14			720	1,339
48	12			630	1,170
54	11			560	1,040
60	9			504	936
66	9			458	852
72				420	781
78				388	721
84				360	669
90				336	625
96				315	585
102	8			296	550
108	5			280	520
114	5			265	492
120	5			252	468

¹ If group III or IV woods are used, the above allowable loads may be increased by 20 percent.

² Wood thicknesses shown are actual nominal thicknesses.

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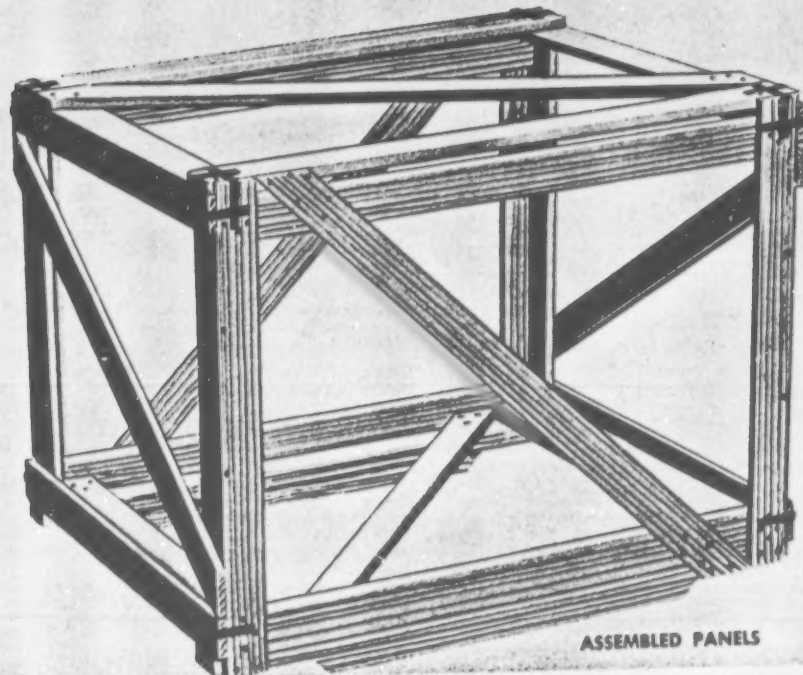
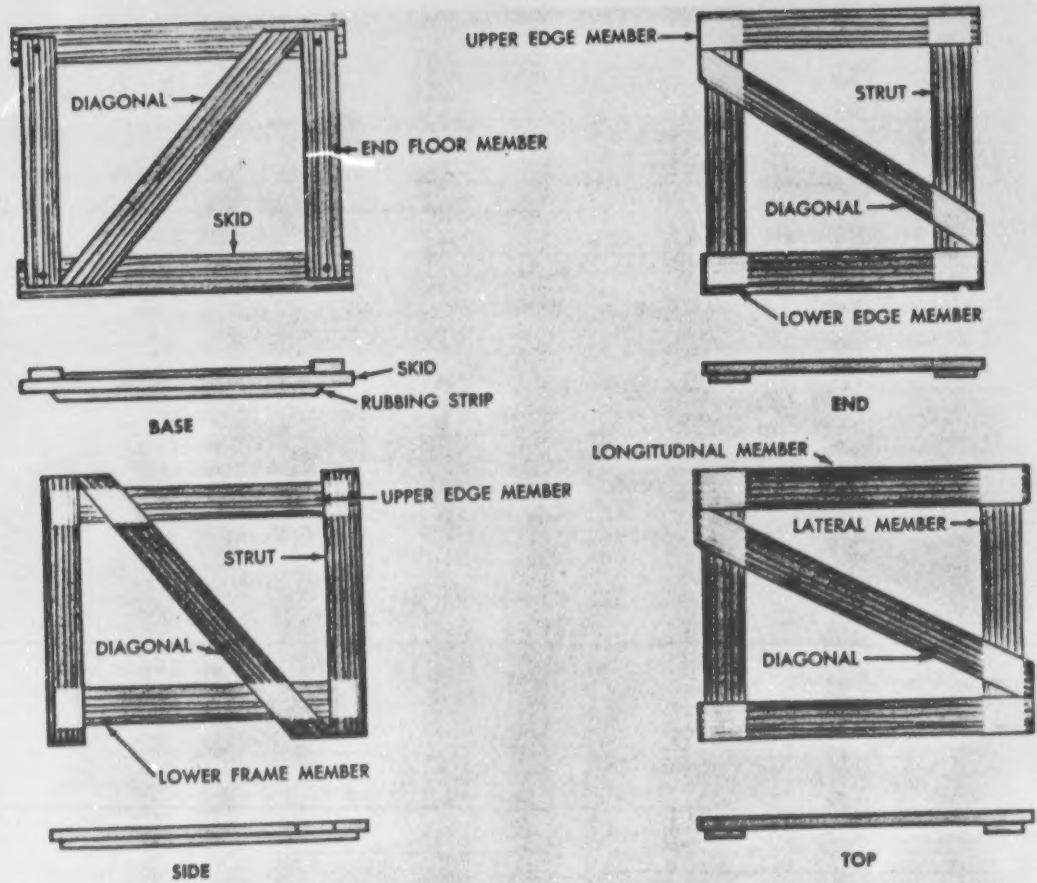
Note. 1. If group III or IV woods are used, the above allowable loads may be increased by 20 percent.

2. Wood thicknesses shown are nominal thicknesses.

3. Use of table to determine thickness of load bearing floorboards. This table is used by first going down the left hand column which denotes the length between outside skids. (The length between outside skids for the crate shown in the illustration is 56 inches, therefore, proceed down the column to 60.) To determine the thickness of load bearing floorboards the weight of the item concentrated on the floorboard is divided by the width of the part of the item in direct contact with the floorboard. The item weight concentrated in the area is shown as 2,500 lbs and the width of the portion of the item on the floorboard is 5 inches. Therefore, the 500 is obtained by dividing 5 into 2,500. Starting at the number 60, previously determined, continue across the columns until the lowest allowable load figure in the table that includes the load per inch of floorboard width generated by the item is found. This is 504. The required thickness of the load bearing floorboard is shown at the top of the column (5 1/2 inches for this particular item).

Figure 6-22. Use of Table to determine thickness of load bearing floorboards.

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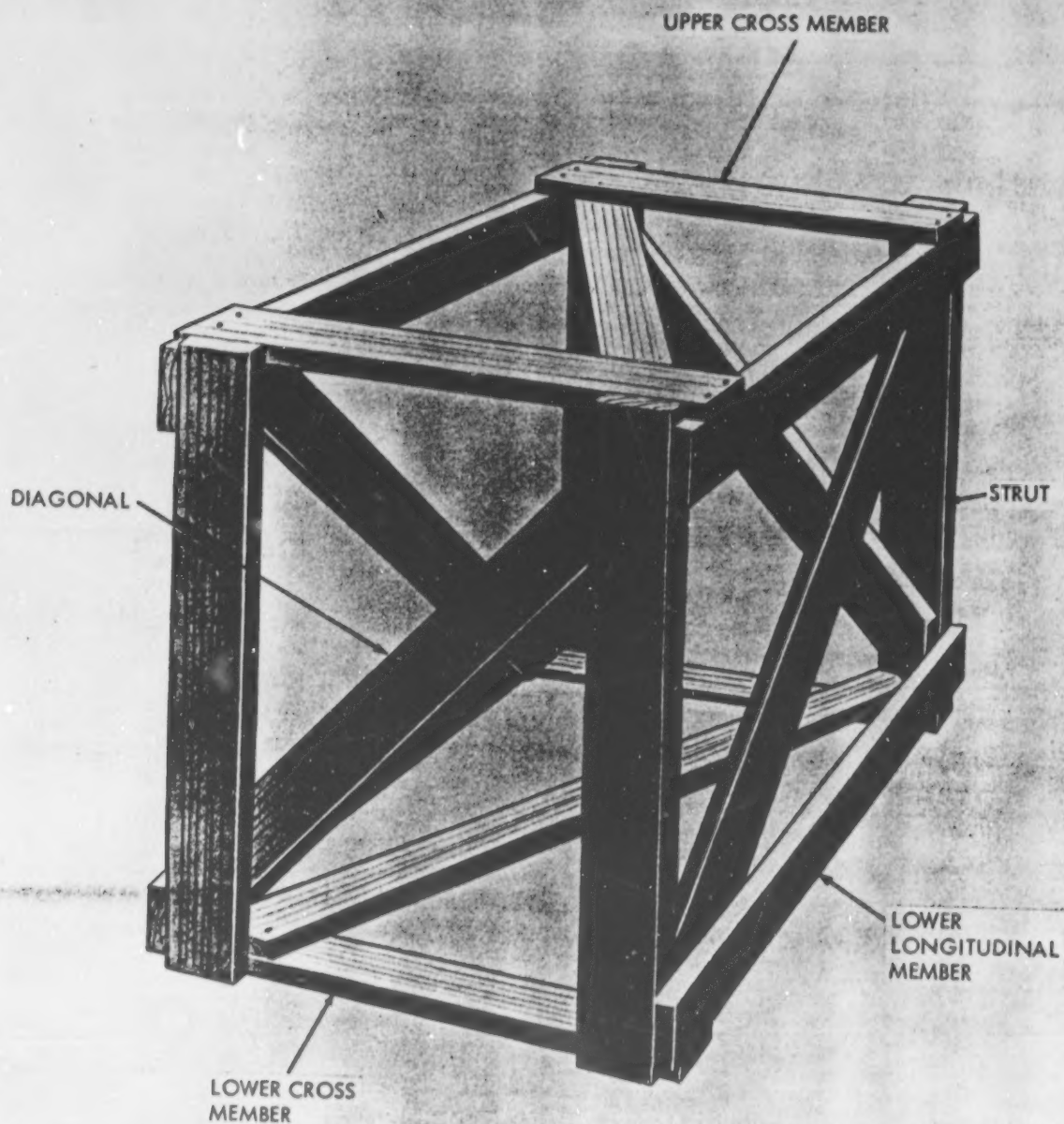
ASSEMBLED PANELS

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Figure 6-23. Type 1, style A crate assembly (PPP-C-650).

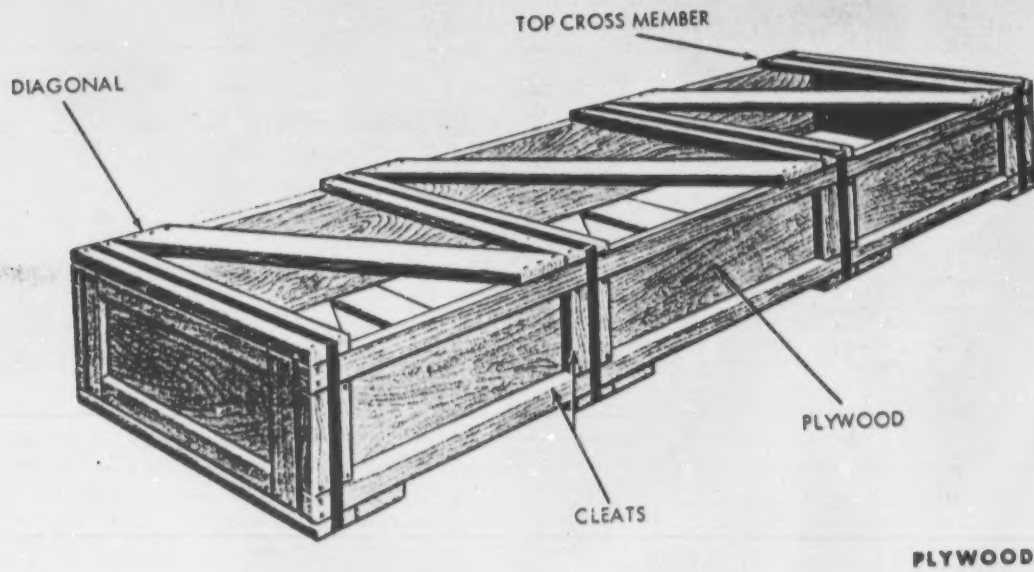
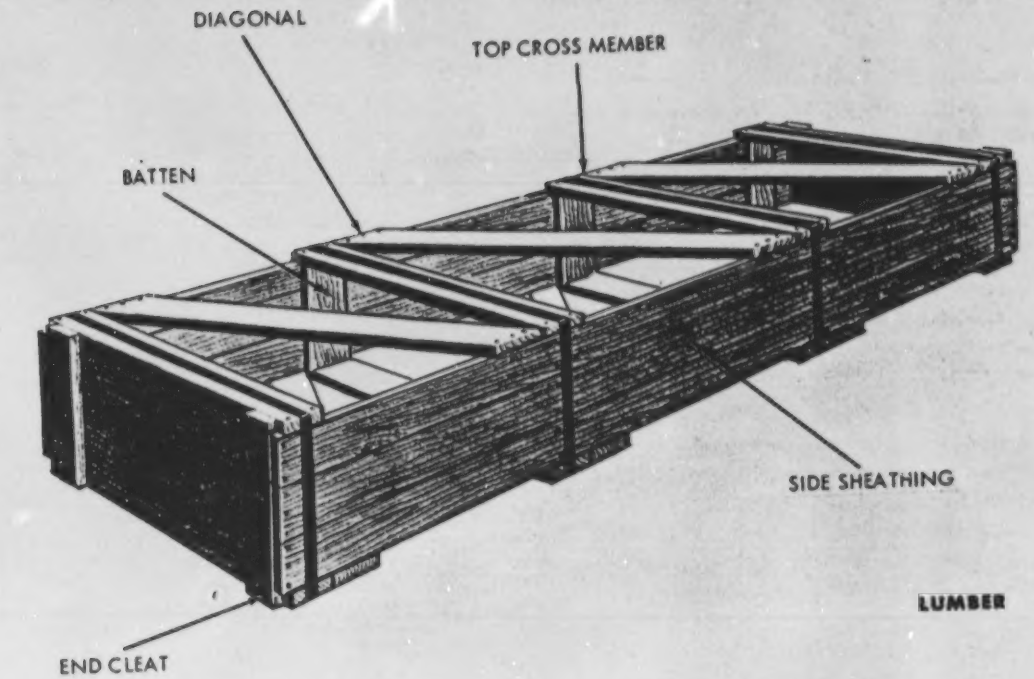
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Figure 6-24. Type I, style B crate assembly (PPP-C-650).



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Figure 6-25. Type II, style A crate assembly (PPP-C-650).

267 (1) *Plywood end panels.*

(a) Position the plywood piece for the end panel on a nailing table.

(b) Position the through cleats flush with outer edges of the plywood so that the grain of the plywood is at right angles to the through cleats.

(c) Cut filler cleats to fit between the through cleats and position them flush with the outer edges of the plywood.

(d) Secure the cleats to the plywood with nails that will go through the cleat and plywood and clinch at least one-eighth of an inch. Use two rows of nails spaced 4 inches apart in each row (staggered pattern).

(2) *Plywood sides (table 6-7).*

(a) Position the sheet of plywood for the sides on a nailing table with the direction of the grain parallel to the length of the crate.

(b) Position the through cleats parallel or at right angles to the grain of the plywood, whichever is economical, flush with the outer edges of the plywood (fig 6-25).

(c) Cut the filler cleats to fit between the through cleats.

(d) Use intermediate cleats when the clear distance between the regular cleats exceeds 36 inches.

(e) Secure the cleats to the plywood with nails that will go through the cleat and the plywood and clinch at least one-eighth inch. Use two rows of nails spaced 4 inches apart in each row (staggered pattern).

(3) *Lumber ends.* Lumber ends are constructed similar to a Style 4 nailed wood box (para 3-2d(5)).

(a) Position the lumber on the nailing table.

(b) Position the end cleats at right angles to the grain of the lumber.

(c) Secure the cleats to the lumber with nails that will penetrate both the cleat and the plywood and clinch at least one-eighth inch.

(d) Use two rows of nails spaced 4 inches apart in each row (staggered pattern).

(4) *Lumber sides.* See paragraph 6-6a(2) for requirements.

c. Assembly of Style A.

(1) *Sides to the ends (plywood).*

(a) Position the end panels between the sides so that the through cleats of the end panels are adjacent to the filler cleats of the side panel.

(b) The top and bottom of the end panel should be flush with the top and bottom of the sides.

Table 6-5. Minimum Material Sizes for Ends of Type II, Style A Crates (PPP-C-650).

Maximum net load (lb)	Thickness of plywood sides (in.)	Thickness of lumber ends (in.)	Thickness and width of end cleats (in.)
100 -----	1/4	3/4	3/4 x 2-3/4
250 -----	3/8	3/4	3/4 x 3-5/8
500 -----	1/2	1-1/16	1-1/16 x 3-5/8
1,000 -----	1/2	1-5/16	1-5/8 x 3-5/8

Table 6-6. Minimum Material Sizes for Sides of Type II, Style A Crates (PPP-C-650).

Maximum net load (lb)	Thickness of plywood ends (in.)	Thickness of lumber sides (in.)	Thickness and width of cleats for plywood sides (in.)
100 -----	1/4	3/4	3/4 x 2-3/4
250 -----	3/8	3/4	3/4 x 2-3/4
500 -----	1/2	1-1/16	7/8 x 3-5/8
1,000 -----	1/2	1-5/16	7/8 x 3-5/8

(c) Secure the side panel to the end panel by nailing through the cleats of the side panel into the through cleat of the ends. See table 6-7 for nail size and spacing.

(2) *Sides to the ends (lumber).*

(a) Position the ends between the lumber sides so that the through cleats of the end panels are adjacent to the lumber of the side panel.

(b) Secure the lumber to the ends and cleats with two rows (staggered pattern) of coated sinker nails. The size and spacing of nails are found in table 6-7.

(3) *Top and bottom crossmembers and diagonals to the sides (plywood).*

(a) *Top and diagonals to the sides.*

1. Position the members at right angles to the sides with the ends flush with the outside edges of the through cleats of the sides and the filler cleats of the end.

2. Space the crossmembers not more than 36 inches apart.

3. Secure the crossmembers with two nails in each joint for 1 x 4-inch members; use three nails in each joint for 1 x 6-inch members.

4. Use eightpenny nails for side cleats and sides less than 1 inch thick. Use ninepenny sinker nails for sides more than 1 inch thick.

(b) *Top and bottom diagonals to the sides.*

1. Position the ends of the diagonals between and against the sides of crossmembers.

Table 6-7. Nailing Requirements for Type II, Style A Crates (PPP-C-650)

Nailing cleated plywood sides to cleated plywood or lumber ends ¹			Nailing lumber sides to lumber ends ¹		
Plywood thickness (inch)	Penny size of nail	Nail spacing (inches)	Thickness of sides (inches)	Penny size of nail	Nail spacing (inches)
1/4	8	3	3/4	8	2-1/2
3/8	10	3-1/4	1-1/16	10	2-3/4
1/2	12	3-1/2	1-5/16	12	3

¹ Use staggered pattern when ends are constructed of lumber.

2. The angle of the diagonals to the sides should not exceed 60 degrees nor be less than 30 degrees with the diagonals of the top and bottom.

3. Secure the diagonals to the sides with eightpenny nails for side cleats and sides less than one inch thick. Use ninepenny sinker nails for sides more than one inch thick.

(4) *Strapping* (fig 6-25).

(a) Apply a girthwise strap (centered) over each set of cleats and cross members.

(b) Use 3/4 x 0.020-inch straps for loads under 250 pounds. Use 3/4 x 0.028-inch straps for loads over 250 pounds.

(c) Staple the straps to the cleats using 12-gauge staples not longer than 3/4 inch, spaced six inches apart.

(d) Drive the staples so that the strapping is not damaged.

(5) *Waterproofing of contents*. Interior shrouds are used for water shed protection of items packed in open crates. They are left open at the bottom to permit free air circulation around the item. Materials used for interior shrouds may also be used to provide waterproof protection to heavy parts and sections of parts. Use waterproof paper covered by Specification PPP-B-1055 or MIL-B-13239 for this purpose (fig 6-20).

6-7. Type II, Style B—Light Duty Crate (PPP-C-650)

a. *Design Requirements* (fig 6-26). The load and size limitations are as specified in table 6-3. This style crate is similar in design to Style A; however, Style B is lumber sheathed only.

(1) *Ends*. The ends are constructed of horizontal boards and vertical end cleats. The end boards are 1 inch in thickness and are not less than four inches wide. The size of the end cleats are as specified in table 6-8 based on the maximum net weight of contents.

(2) *Sides*.

(a) The sides are constructed of two or more 1-inch boards not less than 4 inches wide.

(b) Boards are nailed to inside battens spaced as specified in table 6-8. The size of the battens are based on the net load limit.

(c) When specified for net loads over 200 pounds, interior side battens are replaced by exterior side cleats for forklift handling of crates on their sides. The spacing is shown on figure 6-26. The size of exterior cleats are shown in table 6-8. On short one-panel crates, when net loads exceed 200 pounds, end cleats are 2 by 4 inches in size and exterior cleats are not required.

(3) *Top and bottom*. At least two cross members and one diagonal member are used for the top and bottom. The maximum center-to-center spacing of the cross members is shown in table 6-8. Diagonals are placed as near to 45 degrees as possible with angles not greater than 55 degrees nor less than 35 degrees. The direction of the diagonals are opposite on the top and bottom.

b. *Fabrication of Style B*.

(1) *Ends*.

(a) Position the lumber on the nailing table.

(b) Position the end cleats at right angles to the grain of the lumber sheathing.

(c) Secure the cleats to the lumber with nails that will penetrate both the cleats and the lumber sheathing and clinch at least one-eighth of an inch.

(d) Use two rows of nails spaced 5 inches apart in each row (staggered pattern).

(2) *Sides*.

(a) Position the lumber sheathing on the nailing table.

(b) Place the inside battens at right angles to the face grain of the side sheathing boards.

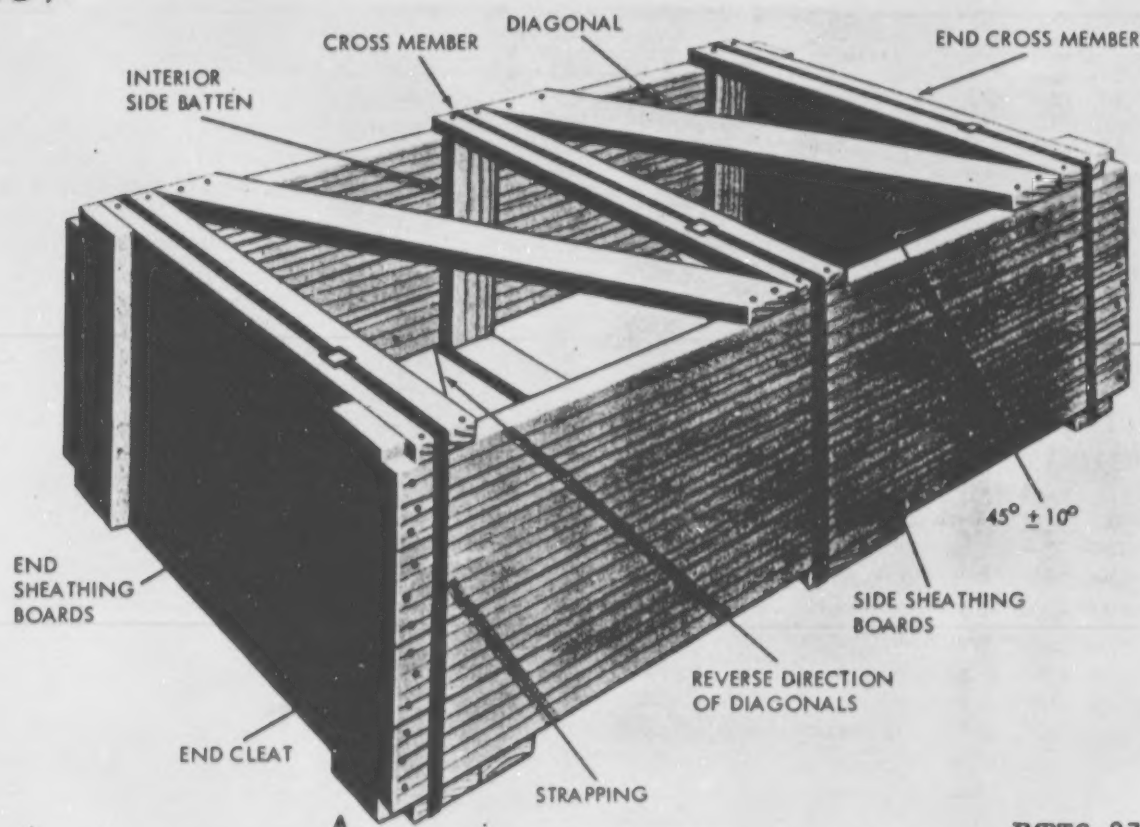
(c) Fasten the battens with two rows of nails spaced 5 inches apart in each row and clinch one-eighth inch.

c. *Assembly of Style B*. The assembly and strapping is similar to that described for the Type II, Style A wood sheathed crate (para 6-6c).

6-8. Type III, Style B—Light Duty Crate (PPP-C-650)

a. *Design Requirements* (fig 6-27). This crate is fabricated as a top section and a bottom section, then brought together for final assembly. There are no size or weight restrictions for this crate

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Figure 6-26. Type II, Style B crate assembly (PPP-C-650).

except as limited by handling methods. The size and spacing of members are shown in table 6-9.

b. Fabrication of Style B.

(1) Top section.

(a) Place the two longitudinal members on the nailing table parallel to each other and spaced the length of the horizontal end cleats apart.

(b) Position the horizontal end cleats between the longitudinal members. Place them back

from the ends of the horizontal members a distance equal to the thickness of the vertical end cleats of the bottom section. Use two eightpenny nails in each end when the longitudinal members are three and four inches wide and three eightpenny nails when they are 6 inches wide.

(c) Place the top crossmembers on the longitudinal members, spaced in accordance with table 6-9. Nail to the longitudinal members using

Table 6-8. Member Sizes for Type II, Style B Crates

Net load limits	Maximum center-to-center spacing of vertical end cleats, top and bottom crossmembers, and interior side battens	End cleats	Interior side battens (place to coincide with top and bottom crossmembers)	Top and bottom crossmembers and diagonals		Exterior side cleats (for forklift handling)
				Widths to 24 inches	Widths over 24 inches	
				(Outside widths)		
<i>Pounds</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
200	48	1 x 3	1 x 2	1 x 3	1 x 4	2 x 2
500	42	1 x 4	1 x 3	1 x 4	1 x 4	2 x 2
1,000	36	2 x 3	1 x 4	1 x 4	1 x 6	2 x 3

Table 6-9. Member Sizes and Spacing for Type III, Style B Crates

Member	Member size					Member spacing		
	Depth of crate			Width of crate		Length of crate		
	0 to 8 inches	Over 8 to 12 inches	Over 7 inches	0 to 24 inches	Over 24 inches	0 to 10 feet	Over 10 to 20 feet	Over 20 feet
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Feet</i>	<i>Feet-Inches</i>	<i>Feet</i>
Longitudinal members -----	1 x 3	1 x 4	1 x 6					
Vertical end cleats -----	1 x 3	1 x 4	1 x 6					
Horizontal end cleats -----	1 x 3	1 x 4	1 x 6					
Top and bottom cross members -----				1 x 4	1 x 6	2	2-6	3
Rubbing strips -----				1 x 4	1 x 6	2	2-6	3

the same number and size of nails as required for the horizontal end cleats.

(2) *Bottom Section.*

(a) Select the proper size of rubbing strips and lower horizontal cross braces from table 6-9. The number and length are the same as the top cross members. Bevel each end of the rubbing strips 45 degrees.

(b) Lay the lower horizontal braces on the nailing table. Place a strap on each member. Use $\frac{3}{4}$ x 0.028-inch straps for loads up to 1,000 pounds and $1\frac{1}{4}$ x 0.035-inch straps for loads over 1,000 pounds. Cut the straps long enough so that they will encircle the assembled crate girthwise, with an allowance for an overlap for sealing purposes.

(c) Place a rubbing strip, with the bevel side up, over each strap, making sure that the straps remain properly aligned. Fasten the rubbing strips to the crossmembers and end cleats using sixpenny nails placed in two rows and spaced five inches apart in each row. Clinch each nail not less than $\frac{1}{4}$ -inch.

(d) Place the longitudinal members and the horizontal end cleats under the horizontal crossmembers with the outer edges of the longitudinal members flush with the ends of the crossmembers. Place the outer edges of the horizontal end cleats in from the ends of the longitudinal members a distance equal to the thickness of the vertical end cleats. Space the horizontal cross members equidistant between the horizontal end cleats. Nail to each crossmember with two eightpenny cement coated nails.

(e) Now turn the section over with the rubbing strips positioned underneath.

(f) Cut the vertical end cleats long enough to permit full nailing to the upper horizontal end cleat when the crate is assembled. Nail them to the lower horizontal end cleats, adjacent to the lower horizontal braces using four nails clinched at least $\frac{1}{4}$ -inch. Nail the longitudinal members to

the vertical cleats using two eightpenny nails in each end of the 3- and 4-inch longitudinal members and three nails in each end of 6-inch members.

c. *Assembly of Style B.*

(1) Position the item to be crated on the lower section.

(2) Place the top section on the item.

(3) Nail the vertical end cleats to the upper horizontal end cleats using four fourpenny coated nails in each cleat. Nail the upper longitudinal members to the vertical end cleats using the same number and size as used on the bottom.

(4) Bring the straps up around the assembled crate, then tension and seal.

6-9. Type IV, Style A—Heavy Duty Crate (PPP-C-650)

a. *Design Requirements (fig 6-28).*

(1) *Base assembly.*

(a) *Skids.* The base is framed on 2 x 4-inch longitudinal skids for loads of 500 pounds or less; 2 x 6-inch lumber is used for loads exceeding 500 pounds.

(b) *Rubbing strips.* See paragraph 6-4a(1)(b) for requirements.

(c) *Load bearing members.* See paragraph 6-4a(1)(c) for requirements.

(d) *End floor members.* See paragraph 6-4a(1)(d) for requirements.

(e) *Diagonals.* Diagonals are 1 x 6-inch lumber. The angle between the skid and the diagonal should be neither less than 30 degrees nor more than 60 degrees. If the angle for a single diagonal is less than 30 degrees, then two diagonals and a 1 x 6-inch center crossmember are required.

(2) *End assembly.* Each end assembly consists of two vertical struts, an upper and a lower edge

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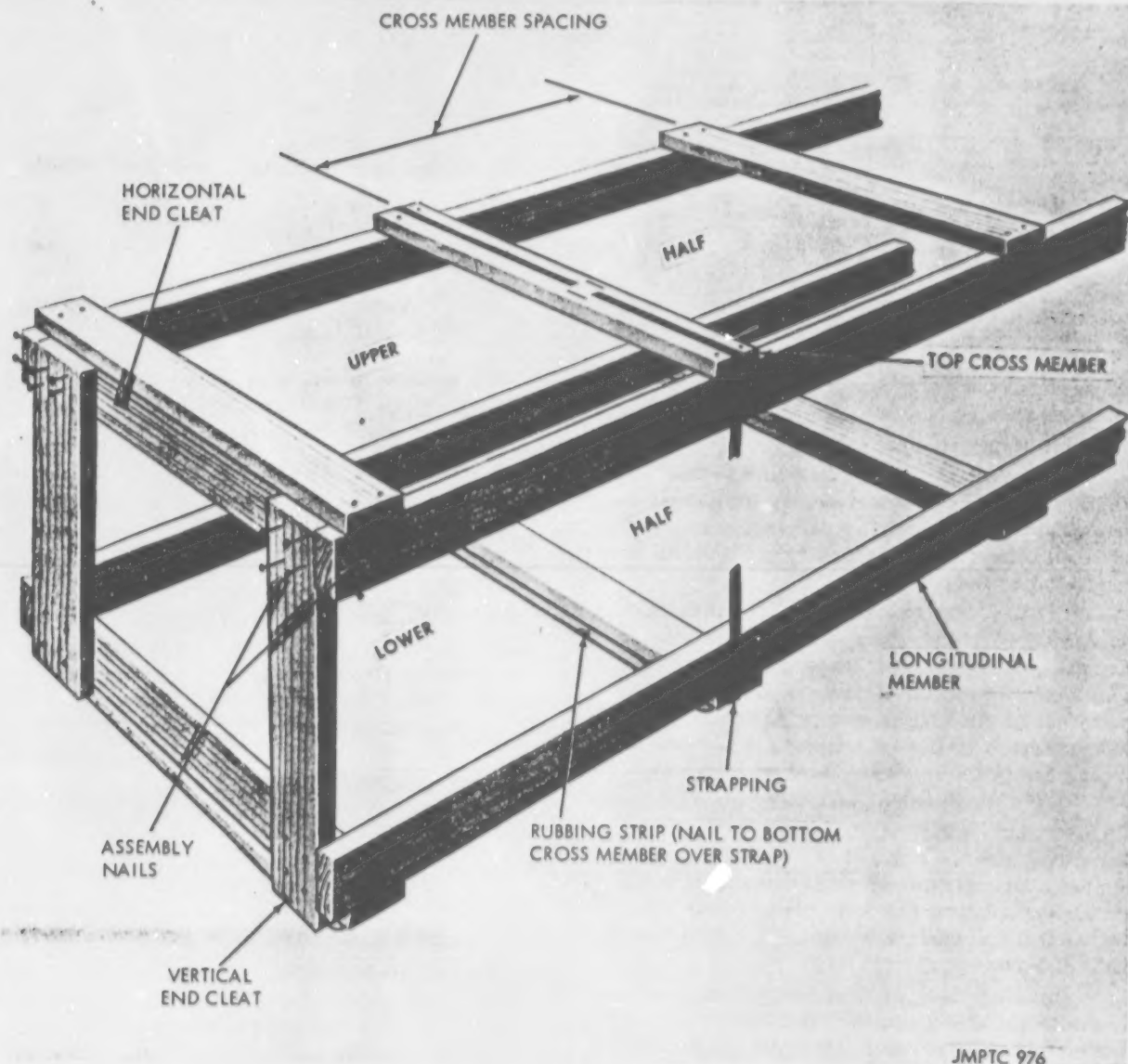


Figure 6-27. Type III, style B crate assembly (PPP-C-650).

member, and a diagonal. All members of the end assembly are 1 x 6-inch material.

(3) *Side assembly.* Each side assembly consists of members that are identical to the ends, with the exception that three vertical struts are required when the length of the crate is greater than 4 feet, or the length is greater than $1\frac{1}{2}$ times the height.

(4) *Top assembly.* The top consist of diagonals and longitudinal and lateral members, all of which are 1 x 6-inch lumber. Longitudinal members must coincide with the vertical struts of the end

and must equal the struts in number. Lateral members must coincide with the vertical struts of the side panels and must also equal them in number. Intermediate lateral members bear on the upper edge members of the sides. Each lateral members are adjacent to the upper edge members of the end panels. This makes a 3-way interlocking corner.

b. Fabrication of Style A.

(1) *Base assembly.*

(a) *Skids and end floor members.*

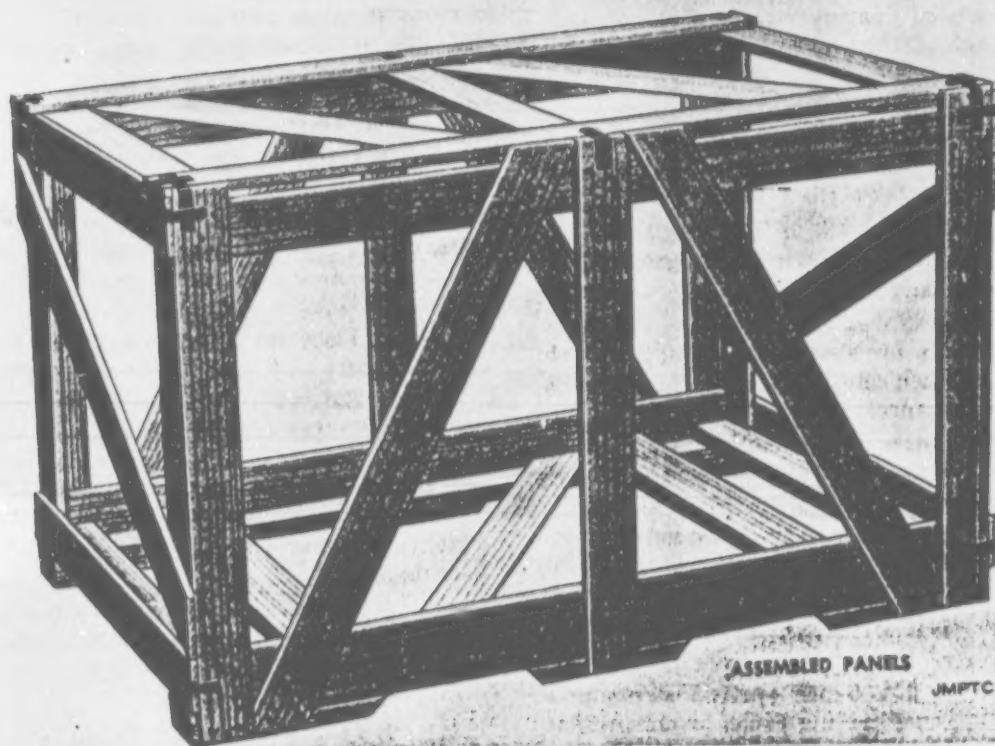
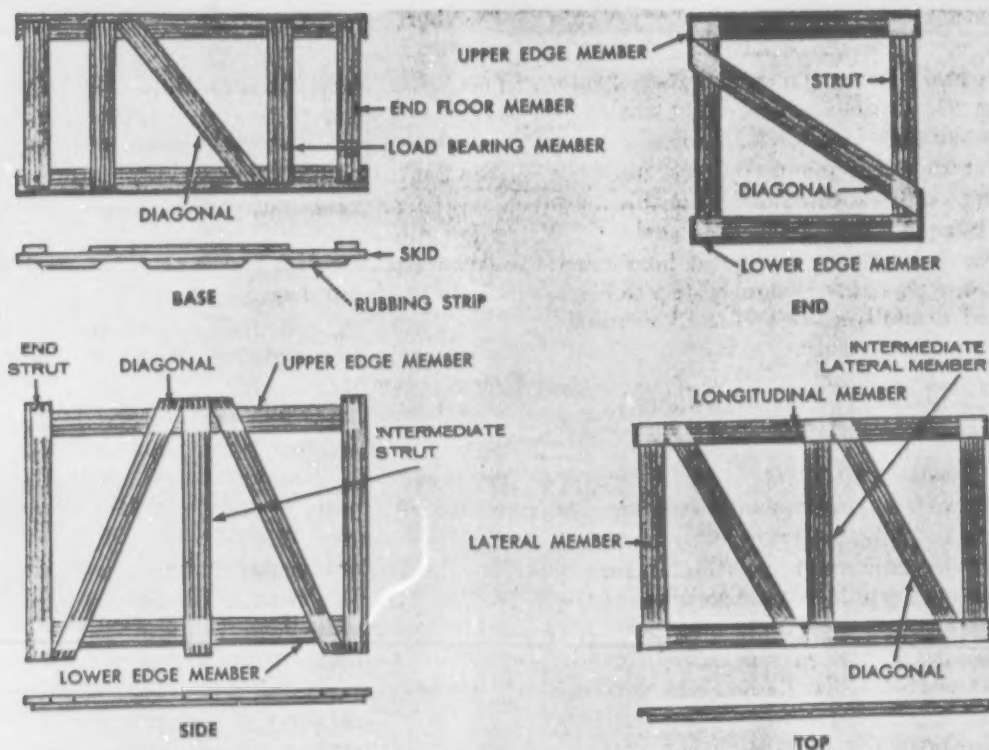


Figure 6-28. Type IV, style A crate assembly (PPP-C-650).

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1. Place the skids in a temporary jig, on a nailing table, or on a hard flat surface.

2. Position the end floor members (headers) with the wide faces down at right angles to the length of the skids.

3. Set the floor members back from the end of the skids a distance equal to the thickness of the lower edge member of the end panel.

4. Place the ends of the end floor members back from the outer edge of the skids a distance equal to the thickness of the lower edge member of the side panel.

5. Attach the end floor members to the skids with one $\frac{3}{8}$ -inch carriage bolt, including a nut and washer.

(b) Load bearing members.

1. Place the load bearing members at right angles to the length of the skids.

2. Set the members back from the edge of the skid a distance equal to the thickness of the lower edge members of the sides.

3. Secure 1-inch members with eightpenny cement coated nails. Use $\frac{3}{8}$ -inch carriage bolts when bolting floorboards over 2 inches thick to the outside skids.

(c) Diagonal members.

1. Place a 1 x 6-inch diagonal member between the load bearing members at an angle not less than 30 degrees nor more than 60 degrees from the outside skids.

2. Use twelpenny cement coated nails to secure the diagonals to the skids. Three nails are required for 4-inch wide material; four nails for 6-inch wide material (fig 6-54).

(d) Rubbing strips.

1. Place 2 x 4-inch rubbing strips on all parallel to the length of the skids.

2. Provide 4 to 8-inch openings at each end of the skids for sling notches, and 12-inch openings on 28-inch centers (positioned to straddle the center of balance) for forklift entry.

3. The piece under the center of balance should not be less than 16 inches long.

4. Secure rubbing strips with two rows of twelpenny cement coated or etched nails spaced 18 inches apart.

(2) End assembly.

(a) Vertical struts, upper and lower end members.

1. Place 1 x 6-inch vertical struts in a temporary jig, on a nailing table, or on any flat surface.

2. Position the upper and lower edge

members on the top of the vertical struts, at right angles.

3. Extend the top edge of the upper edge member over the lower ends of the vertical struts a distance equal to the thickness of the member of the top.

4. Extend the lower edge of the lower edge member beyond the ends of the vertical struts a distance equal to the thickness of the end floor member of the base.

5. Extend the ends of the lower edge member beyond the sides of the vertical struts a distance equal to the thickness of the lower edge member of the side.

6. Use four sevenpenny bright nails at each joint to secure the upper and lower edge members to the vertical struts. Clinch all the nails.

(b) End diagonal members.

1. Place the ends of the 1 x 6-inch diagonals against the lower edge of the upper edge member and against the upper edge of the lower edge member.

2. Extend the ends over the vertical struts a distance equal to the thickness of the vertical strut of the side panel.

3. Secure the diagonal members to the vertical struts using sevenpenny nails. Be sure the nails are clinched. Five nails are required at each joint (fig 6-54).

(3) Side assembly.

(a) Longitudinal and lateral members.

1. Place 1 x 6-inch vertical struts in a temporary jig, on a nailing table, or on a flat surface. Use three vertical struts when the length of the crate exceeds 4 feet, or when the length of the crate is $1\frac{1}{2}$ times its height.

2. Place the 1 x 6-inch upper and lower edge members on the top of the vertical struts.

3. Extend the ends of the vertical struts beyond the upper edge of the upper edge member of the side, a distance equal to the thickness of the longitudinal member of the top, and below the lower edge of the lower edge member of the side, a distance equal to the thickness of the skid and floor members.

4. Secure the upper and lower edge members to the vertical struts with clinched fivepenny bright nails (fig 6-54).

(b) Diagonal members.

1. Position the 1 x 6-inch diagonal members between the vertical struts so that the ends project over the upper edge member a distance

equal to the thickness of the longitudinal members of the top.

2. Extend the diagonals over the lower edge members a distance equal to the thickness of floor members and skids.

3. Secure the diagonals to the upper and lower edge members with fivepenny nails. Five clinched nails are required at each joint (fig 6-54).

(4) *Top assembly.*

(a) *Longitudinal and lateral members.*

1. Position the 1 x 6-inch longitudinal members (same number as end struts) in a temporary jig, on a nailing table, or on a flat surface.

2. Place the 1 x 6-inch lateral members on top of the longitudinal members, at right angles to the longitudinal members.

3. Use the same number of lateral members as vertical struts used for the side panel; set back the ends of the lateral members flush with the outside edge of the longitudinal members, and in from the ends of longitudinal members, a distance equal to the thickness of the upper edge members of the end.

4. Secure the lateral members to the longitudinal members with five clinched eightpenny nails (fig 6-54).

(b) *Diagonal members.*

1. Place the 1 x 6-inch diagonals between the lateral members, the ends flush with the outside edge of the longitudinal members, at an angle of not more than 60 degrees or less than 30 degrees to the longitudinal member.

2. Secure the diagonals to the longitudinal members with five clinched fivepenny nails.

c. *Assembly of Style A.*

(1) *Side panels to the base.*

(a) Position the side panel in line with the base, with the lower edge member resting on the floorboards.

(b) Nail the overlap of the vertical struts and diagonals to the skids using three eightpenny cement coated nails at each joint (vertical struts and diagonals).

(2) *End panels to the base.*

(a) Position the end panels so that the vertical struts fit between the vertical struts of the side panels, with the lower edge members of the end resting on the end floor member of the base.

(b) Nail the overlap of the lower edge member of the end panel to the end floor member with one row of eightpenny coated sinker nails. Space

the nails 6 to 8 inches apart in a staggered pattern.

(3) *Side panels to the end panels.*

(a) Align the vertical strut of the side with the vertical strut of the end.

(b) Nail together with eightpenny coated sinker nails in one row, spaced 8 to 10 inches apart.

(4) *Top to the side and end panels.*

(a) Position the longitudinal members of the top to rest on the upper edge members of the side, and the lateral members to rest on the upper edge members of the end.

(b) Use three eightpenny coated sinker nails at each joint on the side panels. Nail the overlap of the vertical struts and the diagonals of the sides and ends to the longitudinal and lateral members of the top.

(c) Nail the upper edge member of the end panel to the lateral members of the top with one row of eightpenny nails spaced 8 to 10 inches apart.

(5) *Corner straps.*

(a) Fabricate the corner straps from $\frac{3}{4}$ x 0.028-inch nail-on metal strapping. Cut each strap approximately 11 inches long.

(b) Bend the straps in the center at a 90 degree angle to form two legs approximately $5\frac{1}{2}$ inches on each leg.

(c) Use corner straps at each of the eight corners and at the intermediate struts when required.

(d) Apply and secure the straps, centering all of them on the framing members (fig 6-1).

1. Apply the first strap from the end to the side, the second from the end to the top or base, and the third from the side to the top or base.

2. When intermediate struts are required, apply one strap from the top or base to the side.

3. Nail each leg of the strap with three sixpenny nails spaced $1\frac{1}{2}$ inches apart.

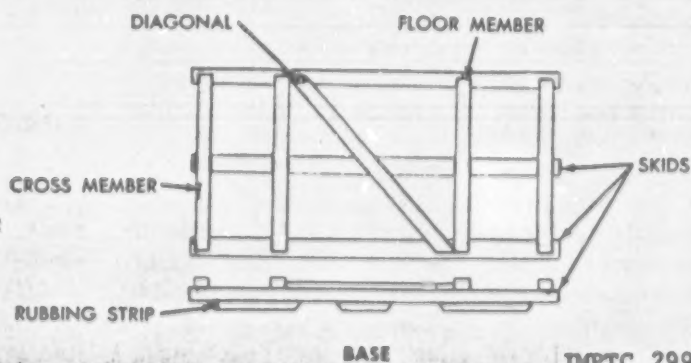
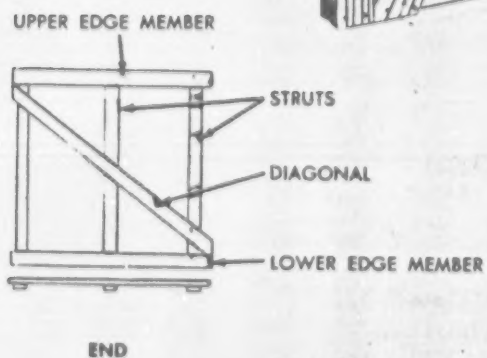
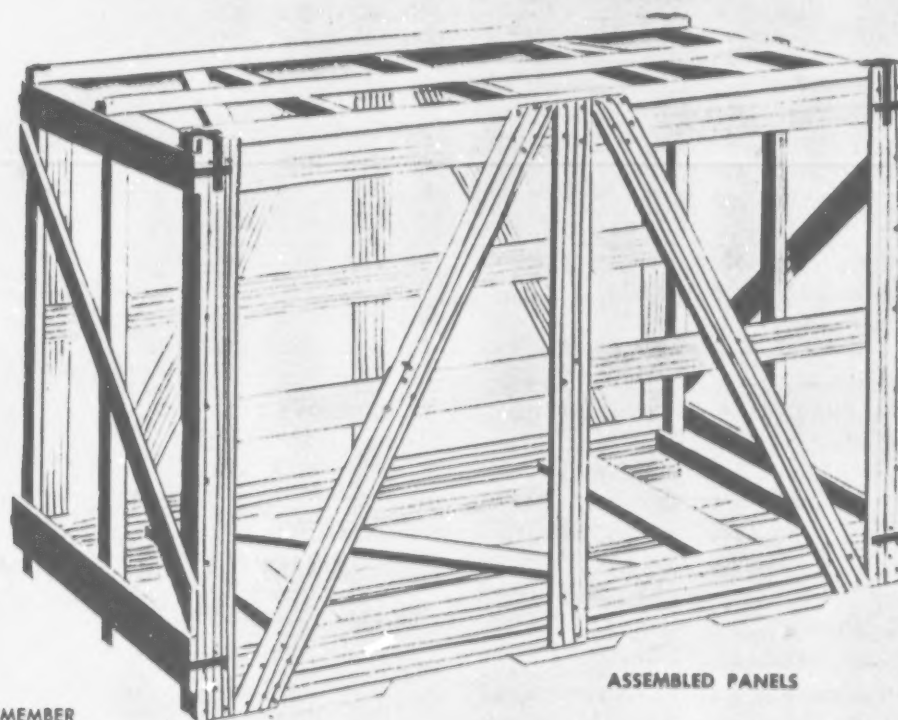
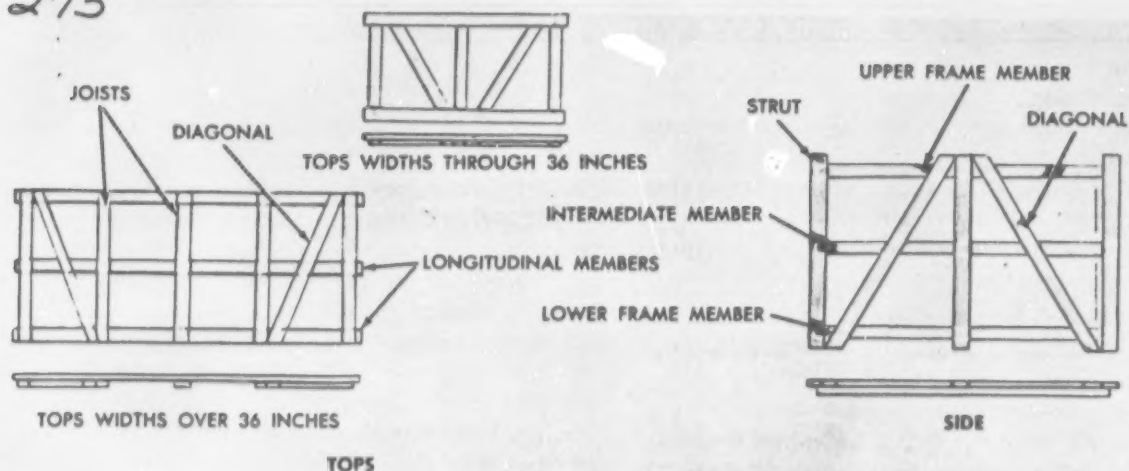
6-10. Type V, Style A—Heavy Duty Crate (PPP-C-650)

a. *Design Requirements (6-29).* The Style A crate may be assembled by nailing (Class I) or bolting (Class 2).

(1) *Base assembly.*

(a) *Skids.* Construct all skids (intermediate and outer) of 4 x 4-inch lumber. When the distance between the outer skids exceeds 36 inches, an intermediate skid is required.

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Figure 6-29. Type V, style A crate assembly (PPP-C-650).

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(b) *Rubbing strips.* See paragraph 6-4a(1)(b) for requirements and figure 6-53 for sling notches and forklift openings.

(c) *Load bearing floor members.* See paragraph 6-4a(1)(c) and table 6-4 for determining the size of load bearing floor members.

(d) *End crossmembers [headers].* Fabricate the end crossmembers from 2 x 6-inch lumber for crates no larger than 4 feet in width. Use 4 x 4-inch lumber for crates over four feet wide. Bolt the crossmembers to each skid with $\frac{3}{8}$ -inch carriage bolts.

(e) *Diagonals.* Diagonals are 1 x 6-inch lumber. The angle between the skid and the diagonal should not be more than 60 degrees nor less than 30 degrees. When the angle of a single diagonal is less than 30 degrees, use two diagonals and 1 x 6-inch center crossmember.

(2) *End assembly.* Vertical struts are 2 x 4-inch lumber. If the width of the crate exceeds 36 inches, use an intermediate strut. The upper and lower edge members are 1 x 6-inch lumber. If the end cross members are 4 x 4-inch, then 1 x 8-inch lower edge members are required. All diagonals are 1 x 6-inch lumber.

(3) *Side assembly.* All vertical struts and diagonals are 1 x 6-inch lumber. Place diagonals between each adjacent strut. Place intermediate vertical struts so that the diagonals form an angle between 30° to 60 degrees. Space the struts a maximum of 40 inches apart. The upper and lower edge members are 1 x 6-inch lumber. When the height exceeds 48 inches, use an intermediate 1 x 6-inch longitudinal member.

(4) *Top assembly.* Longitudinal members of the top are 2 x 4-inch lumber and coincide with the vertical struts of the end. Use an intermediate longitudinal member when the width of the crate exceeds 36 inches. It must coincide with the intermediate strut of the end. Place the 2 x 4-inch top joists on their wide face. Space the joists not more than 40 inches apart for crates up to 36 inches wide, and not more than 30 inches apart for crates over 36 inches wide. The diagonals are 2 x 4-inch lumber. Use one diagonal in each panel of the top on crates over 36 inches wide. Place two diagonals in opposite directions on the top of crates 36 inches or less in width.

b. Fabrications of Style A.

(1) Base assembly.

(a) Skids and end floor members (headers).

1. Place two 4 x 4-inch outer skids in a temporary jig, nailing table, or any other flat surface.

2. Use an intermediate 4 x 4-inch skid if the clear distance between the outer skids exceeds 36 inches.

3. Position the end crossmembers at right angles to the length of the skids, and set back from the ends of the skids a distance equal to the thickness of the lower edge member of the end panel.

4. Use 2 x 6-inch crossmembers for crates 48 inches or less in width and 4 x 4-inch pieces for crates over 48 inches in width.

5. Set the end crossmembers back from the edges of the skids a distance equal to the thickness of the lower edge member of the side.

6. Bolt the end crossmembers to the skids using $\frac{3}{8}$ -inch carriage bolts, one at each skid.

(b) Load bearing members.

1. Place the load bearing members at right angles to the length of the skids.

2. Set the members back from the edges of the skids a distance equal to the thickness of the lower edge member of the sides.

3. Secure 1-inch members with sevenpenny coated nails and 2-inch thick floorboards with twelvepenny nails. Use $\frac{3}{8}$ -inch carriage bolts for floorboards over 2-inch nominal thickness.

(c) Diagonal members.

1. Place a 1 x 6-inch diagonal member between the load bearing floorboards, flush with the ends of the load bearing members.

2. The angle to the length of the skid should not be more than 60 degrees nor less than 30 degrees with the skids.

3. Use five sevenpenny coated nails at each joint to secure the diagonals to the skids.

4. Attach the rubbing strips. See paragraph 6-4a(1)(b) for requirements.

(2) End assembly.

(a) Vertical struts, upper and lower edge members.

1. Place 2 x 4-inch vertical struts in a temporary jig, on a nailing table, or on any other flat surface. Use an intermediate 2 x 4-inch vertical strut when the width of the crate exceeds 36 inches.

2. Position the upper and lower 1 x 6-inch edge member on top of the vertical struts at right angle to the vertical struts. (1 x 8-inch lower edge members are required when the crossmembers of the bases are 4 x 4-inch material.)

3. Extend the upper edge member above the vertical struts a distance equal to the thickness of the end joist of the top.

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4. Set the vertical struts back from the ends of the upper and lower edge members a distance equal to the thickness of the vertical strut of the side.

5. Secure the upper and lower edge members to the vertical struts with four sevenpenny coated nails at each joint.

(b) *Diagonal members.*

1. Place the ends of the 1 x 6-inch diagonals on top of the vertical struts at an angle not more than 60 degrees nor less than 30 degrees.

2. Extend the ends of the diagonals beyond the edges of vertical struts a distance equal to the thickness of the vertical struts and flush with the upper and lower edge members.

3. Secure the diagonal members to the vertical struts with four sevenpenny coated nails at each joint.

(3) *Side assembly.*

(a) *Vertical struts, upper and lower frame members.*

1. Place 1 x 6-inch vertical struts in a temporary jig, on a nailing table, or on a flat surface.

2. Position the upper and lower edge members on the vertical struts. When the crate height exceeds 48 inches, an intermediate 1 x 6-inch longitudinal member (same length as the upper and lower edge member) is required, spaced equidistant between them.

3. Set the upper horizontal member back from the ends of the vertical struts a distance equal to the thickness of the top panel, including the top joist, if used.

4. Place the lower horizontal member back from the ends of the vertical struts a distance equal to the thickness of the floorboards and skids.

5. Set the ends of the horizontal members back from the edges of the vertical struts a distance equal to the thickness of the vertical strut of the end panel.

6. Secure the horizontal members to the vertical struts with five penny bright nails at each joint and clinch.

(b) *Diagonals.*

1. Place the diagonal members between the vertical struts. Use two diagonal members, positioned in opposite directions, between each two adjacent struts.

2. Extend the upper ends of the diagonal members beyond the horizontal members a distance equal to the thickness of the top panel.

3. Extend the lower ends of the diagonal

members beyond the lower horizontal member a distance equal to the thickness of the floorboards and skids.

4. Secure the diagonals to the horizontal members with fivepenny nails, clinched. Five nails are required at each joint.

(4) *Top assembly.*

(a) *Longitudinal and lateral members.*

1. Position 2 x 4-inch longitudinal members on a temporary jig, on a nailing table, or on any other flat surface. Use the same number of longitudinal members that are in the end panel.

2. Place 2 x 4-inch top joists flat and at right angles to the longitudinal members. Space them 40 inches apart for crates up to 36 inches wide and 30 inches apart for crates over 36 inches wide.

3. Secure the longitudinal members to the top joists with twelpenny coated nails. Use three nails at each joint.

(b) *Diagonals.*

1. Position the diagonals on top of the longitudinal members at an angle not more than 60 degrees nor less than 30 degrees, with ends flush with the edges of the diagonals.

2. Use one diagonal in each end panel of the top when the width of the top exceeds 36 inches, or when more than three joists are used.

3. Use one diagonal in each panel of the top when three joists are used, or when the width of the top is 36 inches or less.

4. Secure the diagonals to the longitudinal members with twelve-penny coated nails using three nails at each joint.

c. *Nailed Assembly, Style A.*

(1) *Side panels to the base.*

(a) Position the side panels in line with the base, with the lower frame member of the side resting on the skid.

(b) Secure the overlap of the vertical struts and diagonals to the skids with eightpenny coated sinker nails. Use four nails at each joint. When load exceeds 1,000 pounds, or when only one strut of the side is secured to the skid, use a strap or lag bolt to reinforce the fastenings.

(2) *End panels to the base.*

(a) Position the end panels between the side panels so that the vertical struts of the end panels will be against the ends of the horizontal members of the side.

(b) Lap the upper edge members of the end over the vertical struts of the side.

(c) Rest the lower edge members of the end

on the ends of the skids and overlap the end crossmember (header) of the base.

(d) Secure the lower edge member of the end panel to the end crossmember of the base with eightpenny coated sinker nails. Space the nails 6 to 8 inches apart in a staggered pattern.

(3) *Side panels to the end panels.*

(a) Align the vertical strut of the side with the vertical strut of the end.

(b) Secure the panels with eightpenny coated sinker nails spaced 8 to 10 inches apart in a row.

(4) *Top to the side and end panels.*

(a) Position the top so that the ends of the top joists rest on the horizontal members of the side panel, and the ends of the longitudinal members of the top rest on the upper edge members of the end panel.

(b) Secure the extensions and overlaps of the sides and end panels to adjacent members of the top using eightpenny coated sinker nails (fig 6-54).

(5) *Corner straps.*

(a) Fabricate corner straps from $\frac{3}{4}$ x 0.028-inch nail-on metal strapping. Cut each strap approximately 11 inches long.

(b) Bend the straps in the center at 90° angle to form two legs approximately 5½ inches on each leg.

(c) Use corner straps at each of the eight corners. When intermediate struts are required, place a corner strap at each for reinforcement. Center the straps on the framing members, then apply the first strap from the end to the side, the second from the end to the top, and the third from the side to the top or base. Nail each leg of the strap with three sixpenny nails, spaced 1½ inches apart.

d. Bolted Assembly, Style A. Assemble all bolted (demountable) crates with lag bolts. As an alternate method, when specified, the top, side and end panels may be nailed to each other as in paragraph 6-10c(3) and (4). Fasten the entire unit to the skids and end crossmembers (headers) with lag bolts.

(1) *Side panels to the base.*

(a) Position the side panels in line with the base, with the lower frame member of the side resting on the skids.

(b) Tabulate the minimum number of lag bolts on the basis of the gross weight of contents as specified in table 6-10.

(2) *End panels to the base.*

(a) Position the end panels between the side panels.

Table 6-10. Lag Bolts for Sides of PPP-C-650 Crates

Gross load (pounds)	Minimum number of 3/8-inch lag bolts
1,000	4
2,000	5
3,000	8

(b) Bolt the lower edge member of the end panels to the end crossmember of the base with $\frac{5}{16}$ x 3-inch lag bolts, spaced 12 to 14 inches apart.

(3) *Side panels to the end panels.*

(a) Align the end vertical struts of the side panel and the edge of the end vertical struts of the end panel.

(b) Secure with $\frac{5}{16}$ x 3-inch lag bolts spaced 12 to 14 inches apart.

(4) *Top to the side and end panels.*

(a) Position the top so that the end of the joists rest on the upper edge member of the side, and the longitudinal members of the top rest on the ends of the vertical struts of the end panel.

(b) Bolt the overhang of each strut and diagonals of the side to the edge of the 2 x 4-inch longitudinal members of the top with one $\frac{5}{16}$ x 3-inch lag bolt in each joint.

(c) Bolt the upper edge members of the ends to the end joint of the top using $\frac{5}{16}$ x 3-inch lag bolts spaced 12 to 14 inches apart.

6-11. Type V, Style B—Light Duty Crate (PPP-C-650)

a. Design Requirements (fig 6-30 and 6-31). The Style B crate may be open or covered. It is usually assembled by nailing, but it may be made partially demountable by bolting the sides and ends to the base.

(1) *Base assembly (fig 6-32).*

(a) *Skids.* The size of skids are shown in table 6-11. Skids may be spliced, but not located closer than one-third the length of the skids from the ends and alternated in adjacent skids. Lamination of skids shall be as shown on figure 6-50. When the distance between the outer skids exceeds 42 inches, an intermediate skid is required.

(b) *Rubbing Strips.* Rubbing strips are 2 x 3-inch for 3-inch-wide skids and 2 x 4-inch for all other size skids. See paragraph 6-4a(1)(a) for requirements.

(c) *End headers.* Each end of the base has

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two headers spaced 24 inches apart and bolted to each skid. The headers are the same size as the skids. The outside header is 4 inches wide for crates 2 x 4-inch end struts.

Table 6-11. Skid Sizes for Type V, PPP-C-650 Crates

Net load	Skid size		
	Up to 16 feet long	Over 16 to 20 feet long	Over 20 to 32 feet long
Pounds	Inches	Inches	Inches
Up to 500	2 x 3 (flat)	2 x 4 (flat)	4 x 4 or two 2 x 4 (on edge and laminated).
Over 500 to 2,000	2 x 4 (flat)	2 x 4 (flat)	4 x 4 or two 2 x 4 (on edge and laminated).
Over 2,000 to 3,000	3 x 3	3 x 3	4 x 4 or two 2 x 4 (on edge and laminated).
Over 3,000 to 4,000	4 x 4 or two 2 x 4 (on edge and laminated).	4 x 4 or two 2 x 4 (on edge and laminated).	4 x 4 or two 2 x 4 (on edge and laminated).

(d) *Load bearing floor boards.* The size of the load bearing floorboards is determined on table 6-4 (para 6-4a(1)(c)).

(e) *Diagonals and floorboards.* Diagonals and floorboards, other than load bearing, are 1 x 4-inch for net loads up to 500 pounds and outside crate width of 3 feet, otherwise use 1 x 6-inch. Place the diagonals as close to 45° as possible.

(2) *Side assembly (fig 6-33, 6-34, and 6-35).* The size and spacing of the members are shown in table 6-12. Longitudinal members are single pieces for crates up to 16 feet long. Over 16 feet they may be spliced. Longitudinal members are spaced not more than 4 feet apart.

(3) *End assembly (sig 6-36 and 6-37).* All members are 1 x 4-inch for loads up to 500 pounds and 1 x 6-inch for all other conditions, except that struts are 2 x 4-inch for crates over five feet high and the lower frame members are 1 x 6-inch when the end headers of the base are 2 x 4-inch. They are 1 x 8-inch when the end headers are larger.

(4) *Top assembly (fig 6-38).*

(a) *Cross members and diagonals.* The cross members and diagonals are 1 x 4-inch for loads up to 1,000 pounds and crate widths less than four feet. They are 1 x 6-inch for other conditions. The spacing of the cross members will coincide with that of the side struts.

(b) *Longitudinal members.* The longitudinal members are 1 x 4-inch for loads up to 500 pounds and crate widths up to four feet and 1 x 6-inch for other conditions.

(c) *Top reinforcing joists.* 2 x 4-inch reinforcing joists are used at the loaded center of balance for crates having gross weights over 500 pounds or having an inside width of over 3 feet 6 inches.

b. Fabrication of Style B.

(1) *Base assembly.*

(a) *Skids and end headers.*

1. Place the skids in a temporary jig, on a nailing table or any other flat surface.

2. Position the end headers at right angles to the length of the skids, and set back from the ends of the skids a distance equal to the thickness of the lower edge members of the end panels. The ends of headers are set back from the edges of the skids a distance equal to the thickness of the lower edge members of the side panels.

3. Bolt the ends of the headers to the skids using one 3/8-inch step or carriage bolt in each end.

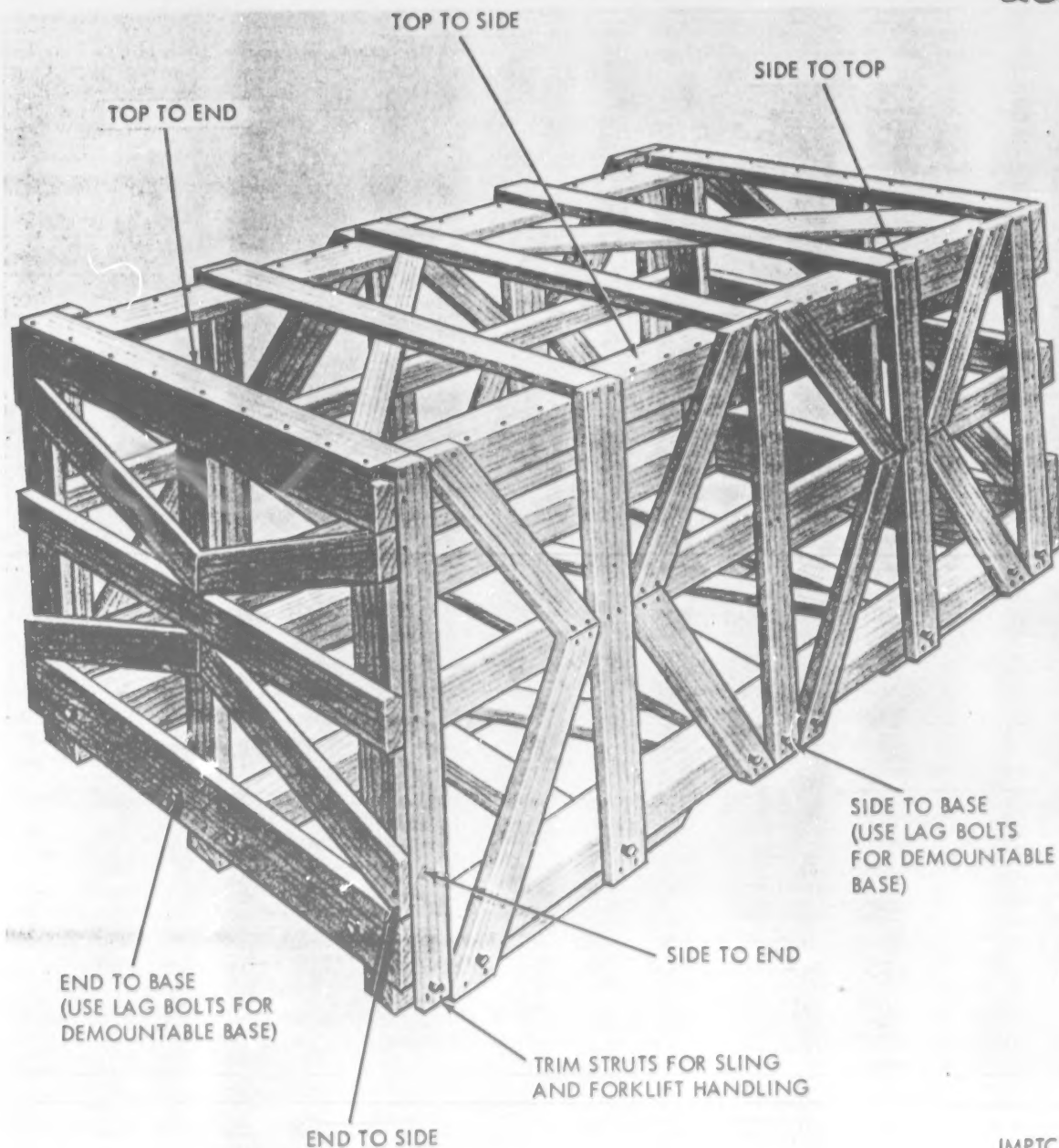
Table 6-12. Frame Member Sizes for Sides of Type V, Style B Crates

Limits of dimension and net load					Member sizes (minimum)			
Length	Net load	Max. strut spacing (on center)			Longitudinals		Struts	Diagonals
		Single panel	Double and triple panel	Upper	Lower	Intermediate		
Foot	Pound	Inch	Inch	Inch	Inch	Inch	Inch	Inch
12	300	42	42	1 x 4	1 x 3	1 x 3	1 1/2 x 3	1 x 4
32	500	48	54	1 x 6	1 x 4	1 x 3	1 1/2 x 4	1 x 4
28	1,000	42	54	1 x 6	1 x 4	1 x 4	1 1/2 x 4	1 x 4
24	2,000	36	48	1 x 6	1 x 6	1 x 6	1 x 6	1 x 4
20	3,000	36	48	1 x 8	1 x 6	1 x 6	1 1/2 x 6	1 x 6
16	4,000	36	42	1 x 8	1 x 8	1 x 8	1 x 8	1 x 6

* For edge struts use 1 x 4 except that 1 x 6 members shall be used when edge struts of ends are 2 x 4 inches in size.

* For edge struts use 1 x 6 members.

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Figure 6-30. Type V, style B open crate assembly (PPP-C-650).

4. Place the second set of end headers back 2 feet, and parallel to the outer set, and secure with $\frac{3}{8}$ -inch bolts.

(b) Load bearing members.

1. Place the load bearing members in the proper location, parallel to the headers.

2. Secure floorboards 2 inches thick or less

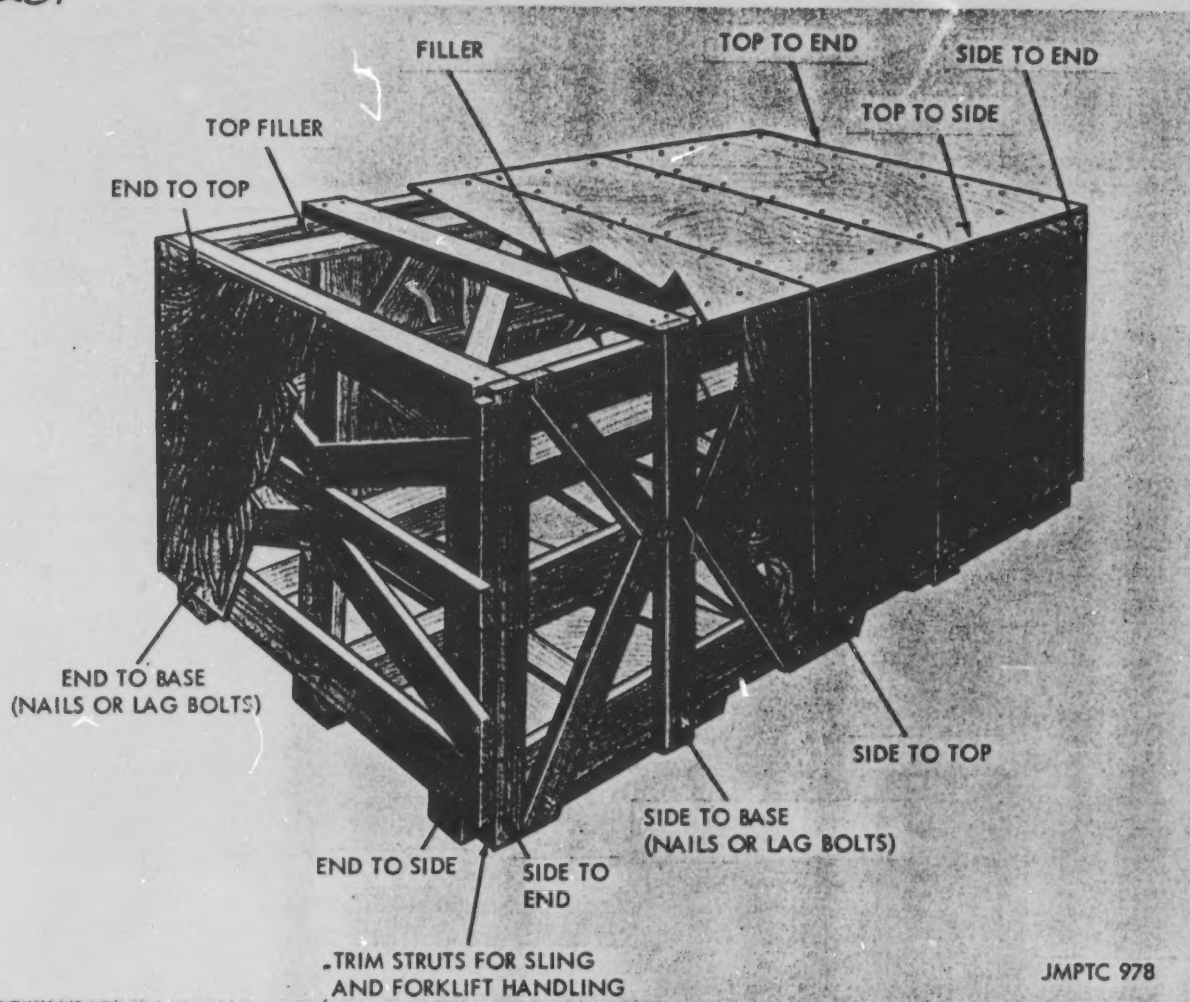
with coated nails using the pattern shown in figure 6-54.

3. Bolt floorboards over two inches thick with one $\frac{3}{8}$ -inch step or carriage bolt in each end.

4. Bolt floorboards over 6 inches wide with two bolts.

(c) Diagonal members.

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Figure 6-57. Type V, style B covered crate assembly (PPP-C-650).

1. Place the diagonal members between the load bearing members with the ends of the load bearing members.

2. Use five sevenpenny coated nails in each end of the diagonals to secure to the skids.

3. Attach the rubbing strips to the underside of the skids using two rows of twelvepenny coated nails spaced 12 inches apart in a staggered pattern.

(2) End assembly.

(a) Vertical struts, upper and lower members.

1. Place the vertical struts in a temporary jig, on a nailing table or any other flat surface. Use an intermediate strut when the width of the crate exceeds 36 inches.

2. Place the upper and lower edge mem-

bers on top of the vertical struts, at right angles to the struts.

3. Add an intermediate horizontal strut if the crate is over 48 inches high.

4. Extend the upper edge member above the vertical struts $\frac{3}{4}$ of an inch.

5. Extend the lower edge member below the vertical struts $\frac{3}{4}$ of an inch.

6. Set the vertical struts back from the ends of the upper and lower frame members $\frac{3}{4}$ of an inch.

7. Secure the upper and lower frame members to the vertical struts with sevenpenny nails conforming to the pattern shown in figure 6-54.

(b) Diagonal members.

1. Place the diagonals on top of the verti-

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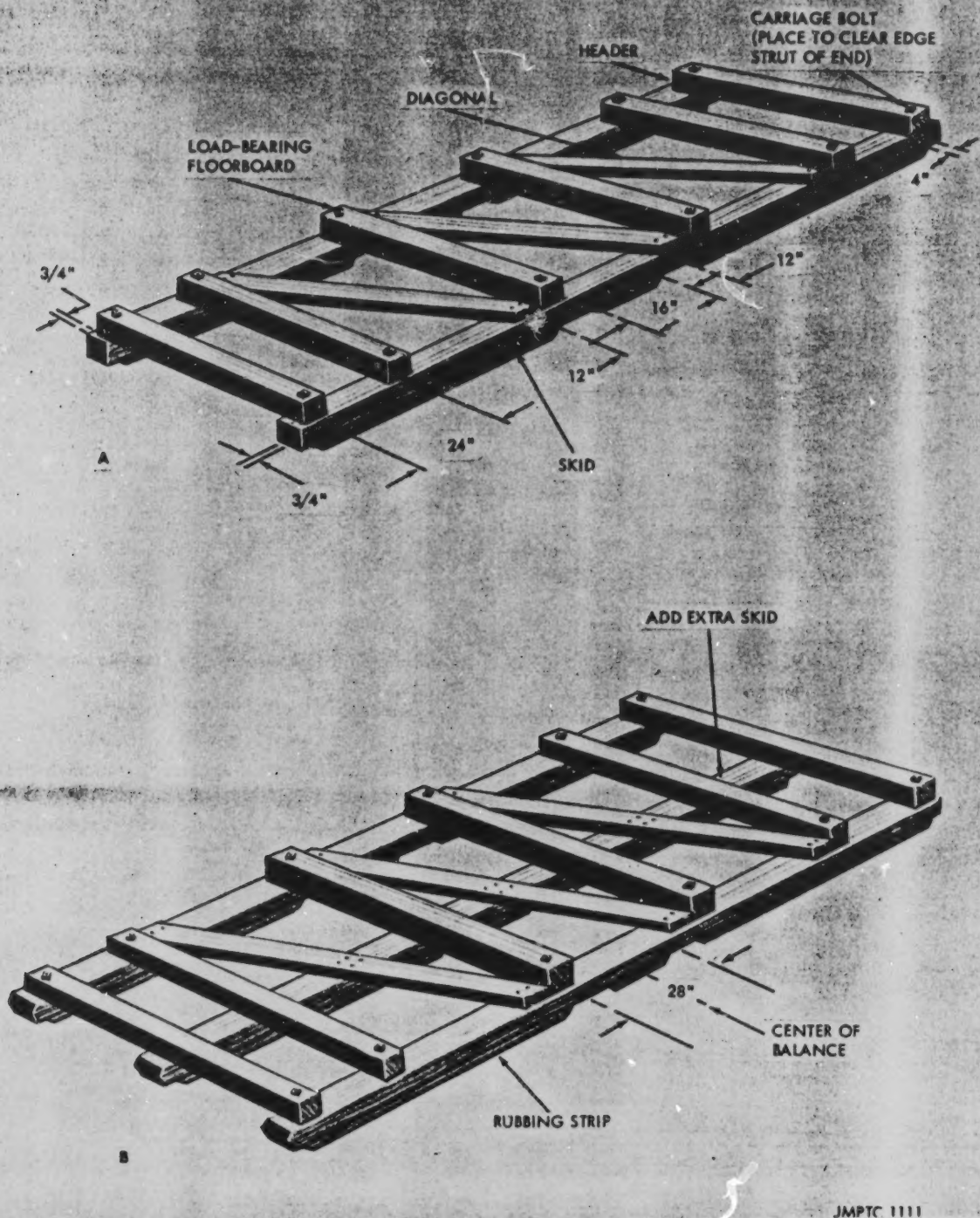


Figure 6-32. Bases for Type V, style B crates (PPP-C-650).

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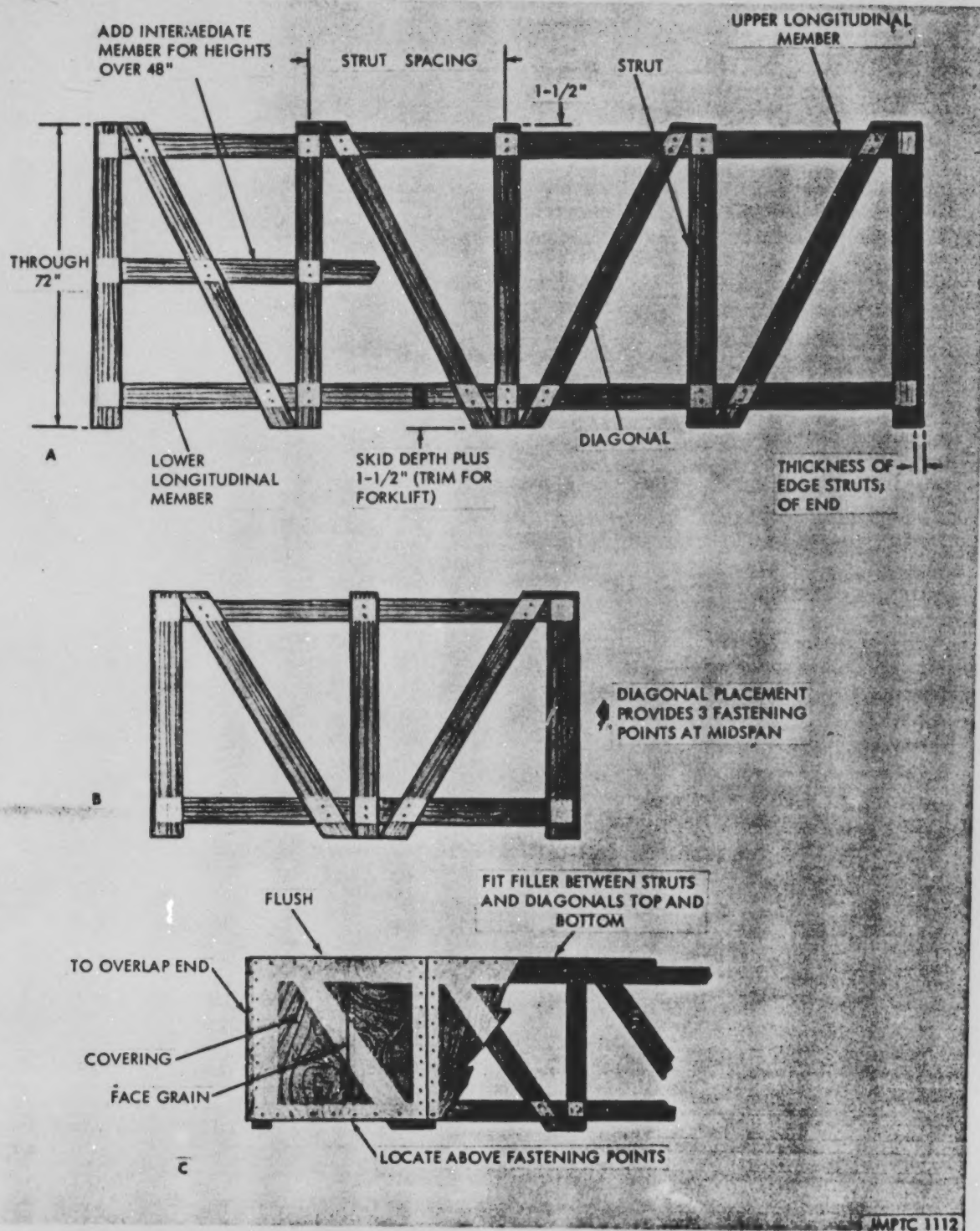
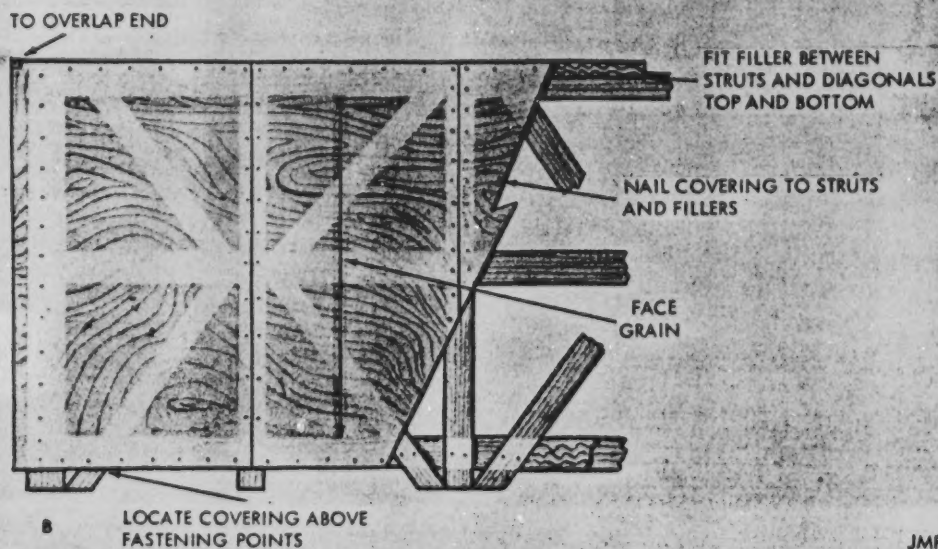
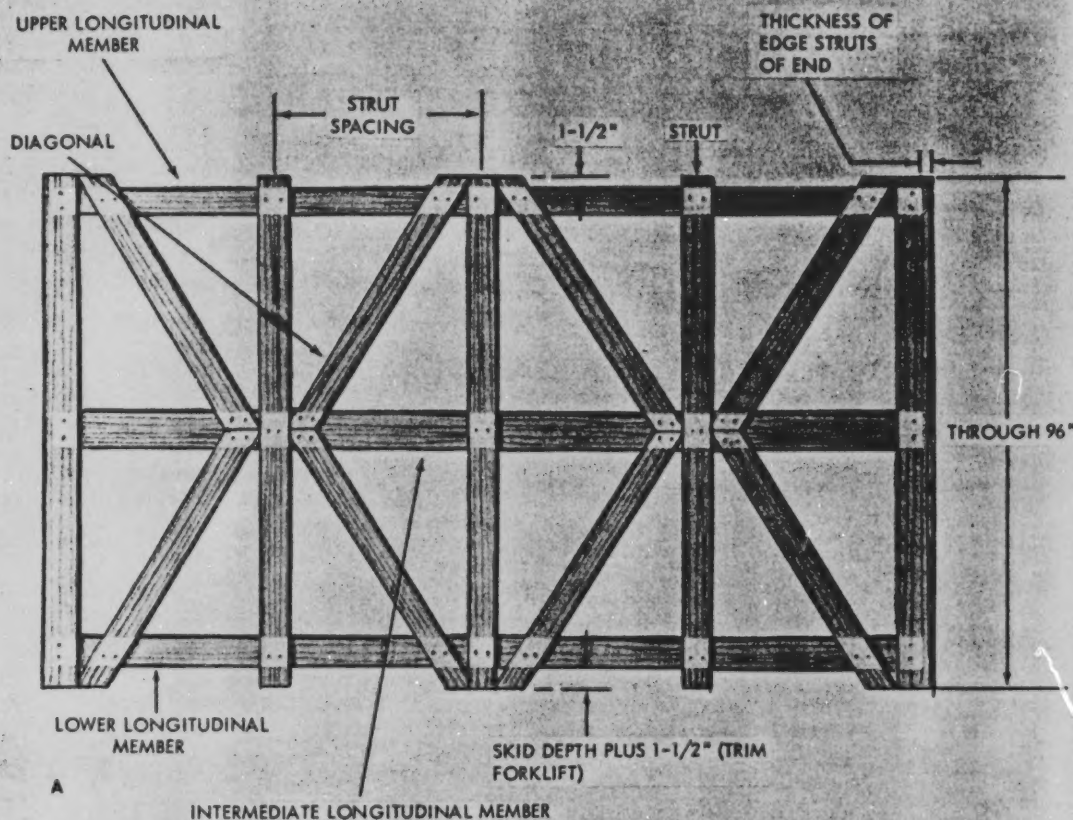


Figure 6-33. Single-panel sides for type V, style B crates (PPP-C-650).

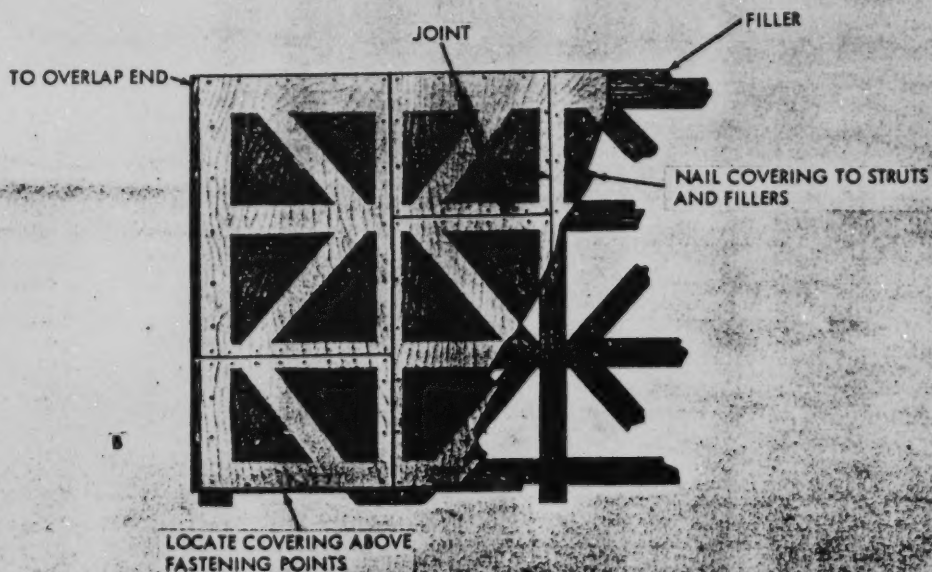
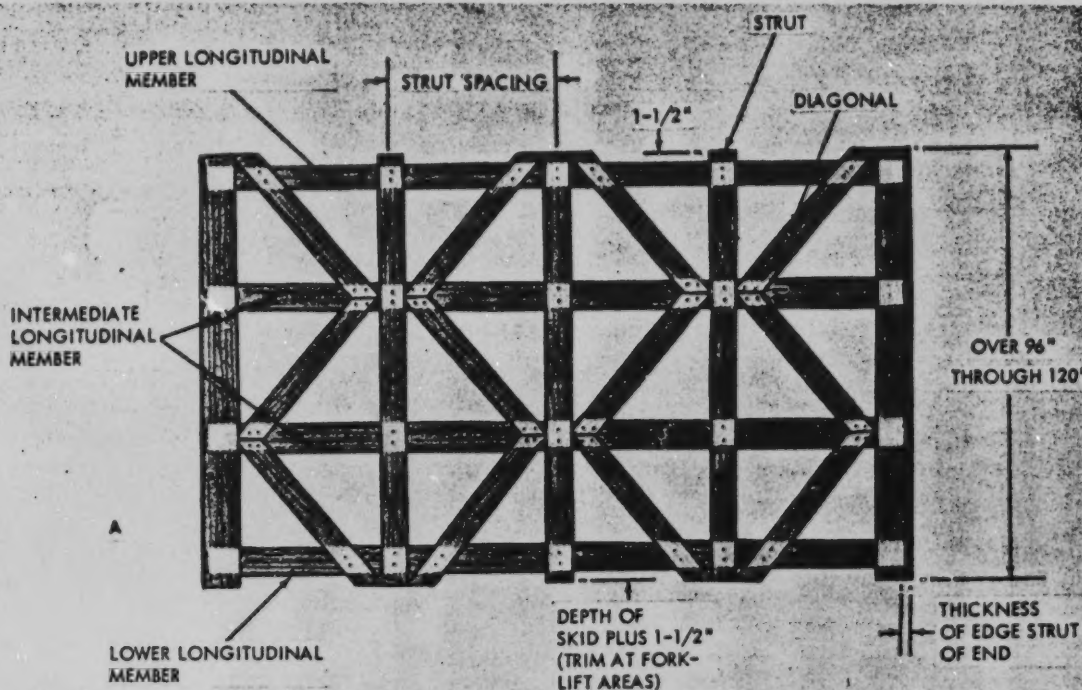
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Figure 6-34. Double-panel sides for type V, style B crates (PPP-C-650) (for heights through 96 in.).

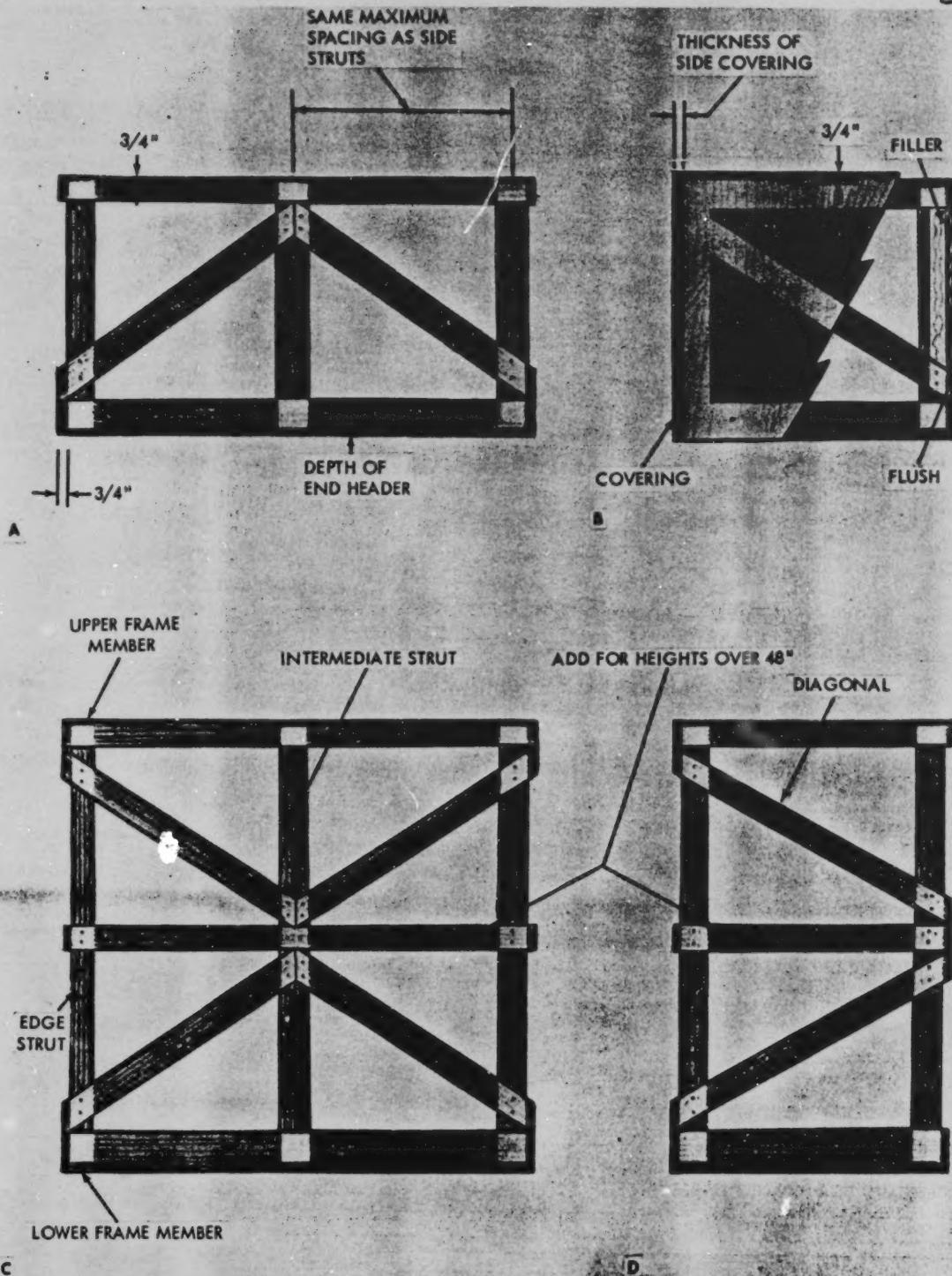
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Figure 6-35. Triple panel sides for type V, style B crates (PPP-C-850) (for heights over 96 in.).

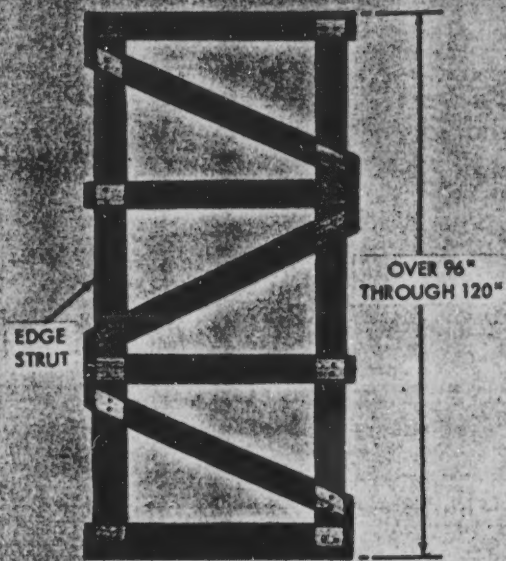
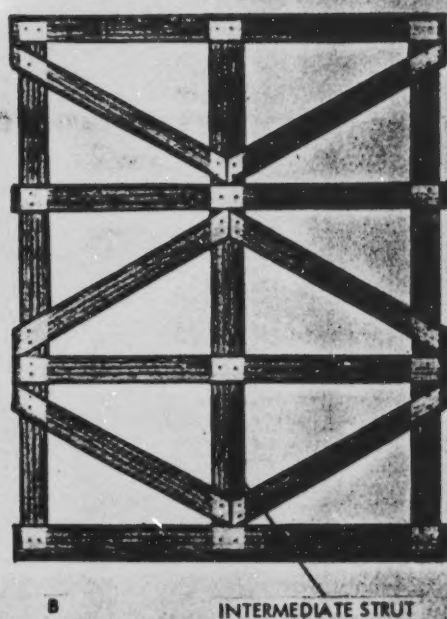
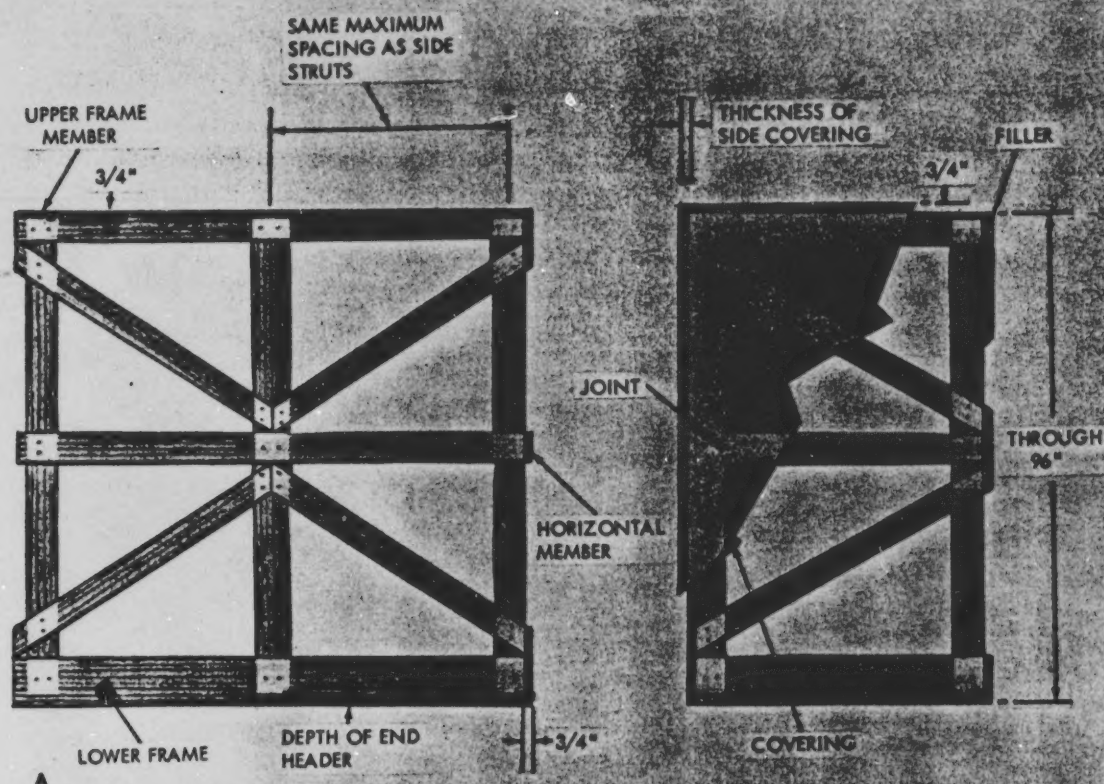
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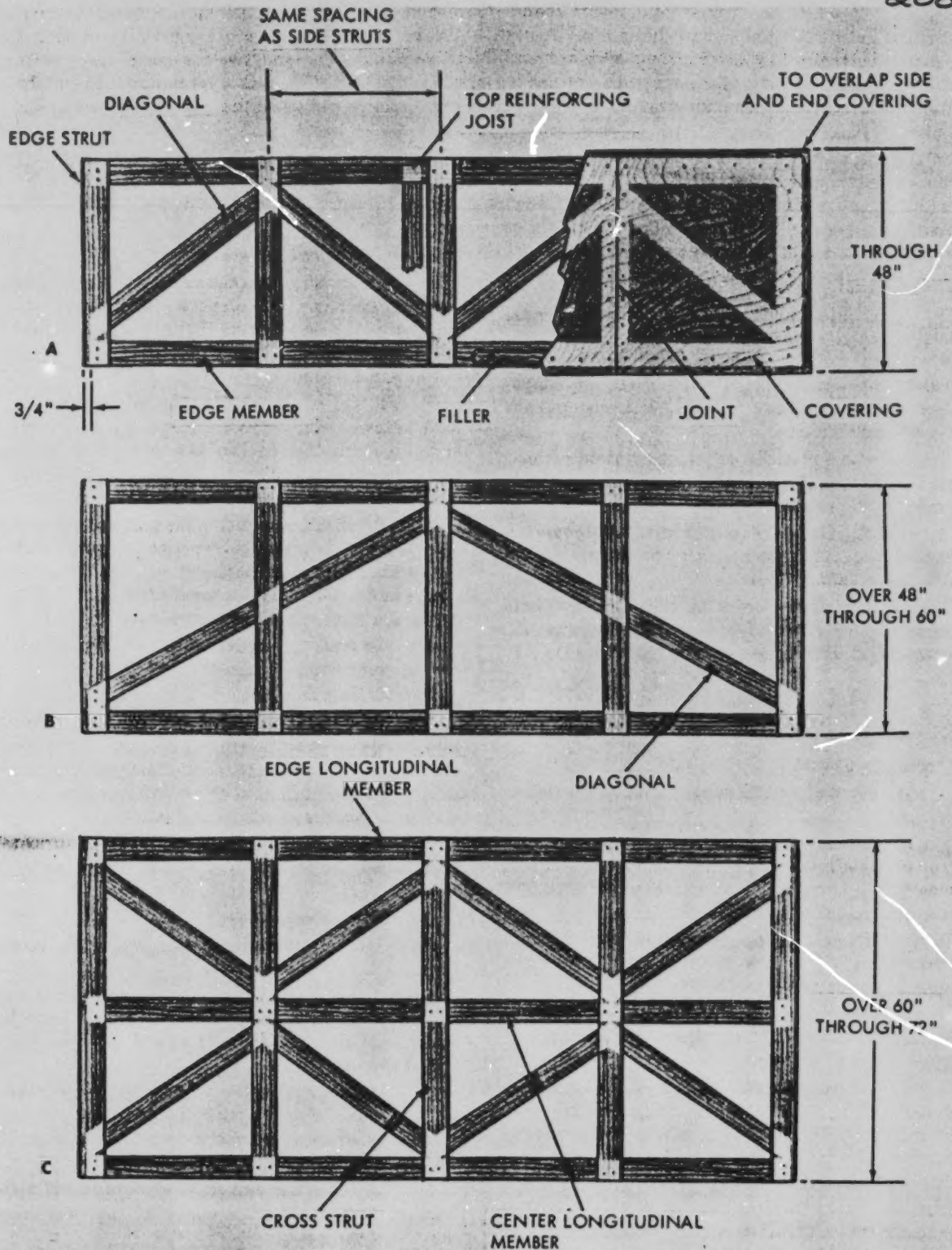
Figure 6-36. Ends for type V, style B crates (PPP-C-650).

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Figure 6-37. Ends for Type V, style B crates (2PP-C-650).



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Figure 6-38. Tops for type V, style B crates (PPP-C-650).

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cal struts between the upper and lower frame members, or when intermediate horizontal struts are used, between the lower frame member and the intermediate strut and between the intermediate strut and the upper frame member.

2. Place the ends of the diagonals flush with the ends of the horizontal frame members. When an intermediate vertical strut is used place one end flush with the ends of the horizontal frame members and the other end at the center of the width of the intermediate vertical member.

(c) *Crate covering.*

1. Nail 3-inch filler pieces, of the same thickness as the diagonals, to the vertical struts with the outer edges of the filler strips flush with the ends of the horizontal members and the diagonals. Nail with two rows of nails 10 inches apart in each row and clinched.

2. Place plywood or paper-overlaid veneer, with a minimum thickness of $\frac{1}{8}$ inch, on top of the fabricated framework.

3. If joints are required in the covering butt them over the center of the width of the struts or cross members.

4. Fasten the covering to the frame members with two rows of coated nails or staples, spaced eight inches apart in each row. Do not clinch.

5. Provide ventilation, if required, in the covering (para 6-15d).

(3) *Side assembly.*

(a) *Vertical struts, upper and lower members.*

1. Place the vertical struts in a temporary jig, or on a nailing table or any other flat surface. Space the intermediate struts equidistance between the end struts.

2. Place the upper and lower longitudinal members on top of the vertical struts, at right angles to the struts (para 6-11a(2)).

3. Place the upper edge of the upper longitudinal member below the upper ends of the vertical struts $1\frac{1}{2}$ inches.

4. Place the ends of the upper longitudinal member in from the outer edges of the end vertical struts the thickness of the end struts of the ends.

5. Place the lower edge of the lower longitudinal member up from the lower ends of the vertical struts a distance equal to the thickness of the skids plus $1\frac{1}{2}$ inches.

6. On single-panel sides add an intermediate horizontal member when the crate is over 4

feet high. On double-panel sides add an intermediate member when the crate is over 6 feet high. On triple-panel sides add two intermediate members when the crate is over 8 feet high. Place them equidistance between the upper and lower members.

7. Secure the horizontal members to the vertical struts using sevenpenny nails, conforming to the pattern shown in figure 6-54. Clinch all nails.

(b) *Diagonal members.*

1. On single-panel sides place a diagonal between each vertical strut with the upper ends flush with the upper ends of the vertical members and the lower ends flush with the lower ends of the vertical members.

2. On double-panel sides place two diagonals between each vertical strut with the outer ends flush with the ends of the vertical struts and the inner ends meeting at the middle of the width of the intermediate horizontal member.

3. On triple-panel sides place three diagonal members between the vertical struts with the outer ends flush with the ends of the vertical struts and the inner ends meeting in the middle of the width of the intermediate struts.

4. Nail to the horizontal members using sevenpenny nails and clinch.

(c) *Crate covering.*

1. Place 4-inch filler strips on the upper and lower horizontal members flush with the outside edges of the struts and diagonals. Fasten using two rows of nails, spaced 10 inches apart in each row, staggered and clinched.

2. Fasten the covering to the fabricated framework and ventilate as required (para 6-11b(2)(c)).

(4) *Top assembly.*

(a) *Longitudinal members and cross members.*

1. Place the cross members in a temporary jig, on a nailing table or any other flat surface. Space them to correspond with the spacing of the side struts.

2. Place the longitudinal edge members on the crossmembers with the outer edges flush with the ends of the crossmembers (para 6-11a(4)).

3. Place the ends of the longitudinal members in from the outer edges of the end crossmembers $\frac{3}{4}$ inch.

4. Place a center longitudinal member equidistant between the other longitudinal edge members when the crate is over 5 feet wide.

5. Nail the longitudinal members to the crossmembers using sevenpenny nails, clinched, and conforming to the pattern shown in figure 6-54.

(b) *Diagonals.*

1. Place the diagonals on the cross members between the longitudinal members with the outer ends flush with the ends of the longitudinal members and the inner ends meeting at the center of the width of the intermediate crossmembers.

2. Nail to the crossmembers using sevenpenny nails, clinched.

(c) *Top reinforcing joists (para 6-11a(4) (c)).*

1. Place the top reinforcing joist on the horizontal edge members and diagonal at right angle to the longitudinal edge members.

2. Nail to the longitudinal member and diagonal using sevenpenny nails.

(d) *Crate covering.*

1. Place 2-inch filler strips between the cross members with the outer edges flush with the outer edges of the longitudinal edge members. Fasten using two rows of nails spaced 10 inches apart, staggered and clinched.

2. Place the crate covering over the fabricated framework with the edges extending over the framework with the edges extending over the framework enough to overlap the covering of the sides and ends.

3. Place a strip of 4-inch waterproof barrier material conforming to MIL-B-13239, grade B, class 2, type CW-1 or T-2 under each joint, extending the full width of the crate.

4. Fasten the covering with two rows of coated nails or staples spaced eight inches apart in each row, staggered. Do not clinch.

c. *Open Assembly Style B.*

(1) *Side panels to the base.*

(a) Position the side panels in line with the base, with the lower frame member of the side resting on the skids.

(b) Secure the overlap of the vertical struts and diagonals to the skids with eightpenny coated nails conforming to the pattern shown in figure 6-54. The number of nails required depends upon the gross weight of the crate (table 6-13). The total number of required nails are divided with one-half on each of the two sides, evenly distributed between the struts and diagonals. A minimum of three nails are used for 3- and 4-inch boards, four nails for 6-inch boards and five nails for 8-inch and wider boards.

Table 6-13. Number of Nails Required to Assemble Sides to Base (Nailed Assembly) of Type V, style B Crates

Gross weight (crate and nails contents)	Total minimum number and type of nails required			
	Sinker or cooler nails		Corker nails	
	Eight- and nine- penny	Ten- penny	Eight- and nine- penny	Ten- penny
Pounds				
1,000	19	18	17	15
2,000	38	36	34	30
3,000	57	54	51	45
4,000	76	72	68	60
5,000	95	90	85	75
6,000	114	108	102	90

(c) For partially demountable crates fasten the overlap of each vertical strut and diagonal to the skids with one lag screw.

1. Use a $\frac{5}{16}$ x 3-inch lag bolt for 2 x 3-inch and 2 x 4-inch skids (placed flat).

2. Use a $\frac{3}{8}$ x 3 $\frac{1}{2}$ -inch lag bolt for 3 x 3-inch skids.

3. Use a $\frac{1}{2}$ x 3 $\frac{1}{2}$ -inch lag bolt for two 2 x 4-inch (laminated on edge) or 4 x 4-inch skids.

4. The total number of lag bolts used are not to be less than those specified in table 6-14, with one-half the total number used for each side. When more than one lag bolt is required in each strut or diagonal, the additional lag bolt is placed on the wider member, near the load-bearing point in a staggered pattern where possible.

Table 6-14. Number and Size of Lag Bolts Required To Assemble Sides to Base (Demountable Base) of Type V, Style B Crates

Gross weight (crate and contents)	Total minimum number of lag bolts		
	Size of bolt for each skid size		
	5/16- x 3-inch bolt for 2- x 3- or 2- x 4- inch skid (flat)	3/8- x 3-inch bolt for 3- x 3- inch skid	1/2- x 3-1/2- inch bolt for 4- x 4-inch or two 2- x 4-inch skids (on edge and laminated)
Pounds			
1,000	8	8	6
2,000	14	10	10
3,000	18	16	12
4,000	24	20	14
5,000	30	26	18
6,000	36	28	22

(2) *End panels to the base and sides.*

(a) Position the end panels between the side panels so that the vertical struts of the end panels are against the ends of the horizontal members of the sides.

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(b) Lap the horizontal members and diagonals of the ends over the vertical struts of the sides.

(c) Rest the lower edge members of the ends on the ends of the skids and overlapping the end crossmembers of the base.

(d) Secure the end struts of the sides to the vertical struts of the ends and the lower edge members of the ends to the end headers of the base with eightpenny coated nails spaced 8 to 10 inches apart.

(e) For partially demountable crates secure the lower end members of the base with $\frac{5}{16} \times 3$ -inch lag bolts spaced one foot apart.

(f) Secure the ends of the horizontal members and diagonals of the ends to the end struts of the sides using eightpenny coated nails conforming to the pattern shown in figure 6-54 (para 6-11c(1) (b)).

(3) Top to the sides and ends.

(a) Position the top so that the end crossmembers of the top fit between the upper frame members of the ends and the edge longitudinal members of the top fit between the vertical struts and diagonals of the sides.

(b) Secure the end crossmembers of the top to the upper frame members of the ends and the longitudinal members of the top to the upper longitudinal members of the sides with eightpenny coated nails spaced eight to ten inches apart.

(c) Nail the upper ends of the struts to the longitudinal members of the top using eightpenny coated nails conforming to the pattern shown in figure 6-54.

(d) Nail the upper longitudinal members of the sides to the reinforcing joist of the top, when used, with tenpenny coated nails in each end of the joist.

d. Covered Assembly, Style B.

(1) The fitting together of the base, ends, sides and top of the covered crate assembly is the same as for the open assembly. The following members are then nailed together with ninepenny coated nails. The nails are driven through the covering and spaced 8 to 10 inches apart.

(a) The edge struts of the sides to the edge struts of the ends.

(b) The struts, diagonals and fillers of the sides to the edge longitudinal members of the top.

(c) The end cross members of the top to the upper frame members of the ends.

(d) The upper, lower, and horizontal mem-

bers, diagonals, and fillers of the ends to the end struts of the sides.

(e) The lower frame members of the ends to the end headers of the base.

(2) The covering of the top is nailed to the fillers of the sides with fourpenny nails spaced 4 to 6 inches apart.

(3) The sides and ends are fastened to base with nails, or with lag bolts for demountable crates, in a manner similar to the open Style B crate.

6-12. Open Wood Crates, MIL-C-3774 (General)

a. *Crate Design.* The open crates covered by Specification MIL-C-3774 consist of framing members partially sheathed in specific areas. This sheathing is applied to protect the enclosed item and acts as a reinforcement to the sides, ends, and top of the crate. These crates are designed to carry large or heavy items. A minimum of 1-inch clearance is required between the item and the nearest framing member of the sides, ends, and top.

Table 6-15. Classification of MIL-C-3774 Crates

Assembly	Maximum net load (lb)	Maximum dimensions (ft)		
		Length	Width	Height
Type I, Nailed ¹	12,000	16	8	8
Type II, Bolted ²	16,000	40	8	16

¹ Nailed assembly—nondemountable.

² Bolted assembly—demountable.

b. *Classification.* Crates designed under this specification may be either bolted or nailed (table 6-15).

(1) *Open bolted crates (demountable).* These crates are designed to withstand a superimposed load of 200 pounds per square foot on the top, including dunnage. These crates may be used as reusable containers.

(2) *Open nailed crates (nondemountable).* Crates designed under this classification are considered to be "one trip" containers. This type may be constructed with a skid- or sill-type base.

c. Material Requirements.

(1) *Wood.* The requirements for lumber are stated in paragraph 6-2a.

(2) *Plywood.* Requirements for plywood are stated in paragraph 6-2b.

(3) *Fasteners.* Nails, strapping, bolts, etc.,

listed in paragraph 6-2c through h will be used as applicable.

6-13. Open Bolted Crates (MIL-C-3774)

a. *Design Requirements.* Demountable crates are designed and constructed so that the major components may be readily assembled or disassembled without damage to the component parts. This accomplished through the use of lag bolts or bolts (fig 6-5).

Table 6-16. Skid Sizes for Bolted MIL-C-3774 Crates

Maximum net load	Maximum length of crate	Size of skids
Pounds	Feet	Inches
2,000	12	3 x 3
4,000	140	4 x 4
5,000	20	4 x 4
10,000	16	4 x 4
5,000	32	4 x 6 (on edge)
16,000	20	4 x 6 (one edge)

¹ For lengths over 32 feet, crate heights shall be not less than 8 feet.

b. Fabrication of Open Bolted Crates.

(1) Skid base.

(a) *Skids.* The size of the skids is based upon the net load and the outside length of the crate, as stated in table 6-16. The number of skids is dictated by the item being packed. However, the clear distance between any adjacent skid is limited to 48 inches center to center (fig 6-39).

1. To prevent splitting, place one carriage bolt crosswise to two to three inches back from each end of the skid (fig 6-39).

2. When necessary, splice and laminate skids according to the details shown on figures 6-50 and 6-51.

(b) *Rubbing strip.* Rubbing strips are required on all 4 x 4-inch skids and must be at least 2-inch material, approximately as wide as the skid. Bevel these members at a 45° angle and set back approximately 8 inches from the ends of the skids. Bevel the inner ends of the notches at a 45° angle. These areas will serve as sling points and for forklift entries.

(c) *Headers.* The sizes of end headers and bolts are outlined as follows:

Skid Size (inches)	Header size (inches)	Bolt diameter (inches)
3 x 3	3 x 3	3/8
4 x 4	4 x 4	1/2
4 x 6 (on edge)	4 x 4	1/2

Extend headers beyond the outside faces of the outer skids three-fourths of an inch to support the lower frame members of the sides.

(d) *Load bearing floorboards.* Place load bearing floorboards where the concentrated load of the contents occur. Determine the size of load bearing floorboards from table 6-4. Set the end floorboards back from the end of the skids a distance equal to the thickness of the end sheathing.

1. Space floorboards three-fourths inch apart for drainage.

2. Nail floorboards up to two inches thick to the skids with three or more sixteenpenny coated or etched nails at each intersection with a skid.

3. Bolt floorboards up to 4 inches wide with one bolt in each skid. Boards over 4 inches wide require two bolts in each skid.

(e) *Forklift area.* The forklift area extends over the area of 42 inches in from the ends of the skids and may consist of the following:

1. Forklift headers spaced 20 to 40 inches in from each end header.

2. 2-inch-thick boards extending 42 inches in from each end.

3. Plywood for narrow crates.

(f) *Diagonals.* 1 x 6-inch diagonals are used between forklift areas and loadbearing members. The diagonals are nailed to the skids and to each other where they intersect.

(2) *Sides.* The sides consist of upper, lower, and intermediate members, vertical struts, diagonals, and corner sheathing.

Table 6-17. Frame-Member Sizes (Sides of Bolted Crates)

Limits		Size of members		
Length	Net load	Upper frame members	Lower frame members	Horizontal braces ¹
Feet	Pounds	Inches	Inches	Inches
12	500	5/8 x 4	5/8 x 4	5/8 x 4
10	2,000	1 x 4	1 x 4	1 x 4
16	4,000	1 x 6	1 x 6	1 x 6
12	8,000	1 x 6	1 x 6	1 x 6
40	4,000	2 x 4	2 x 6	2 x 4
16	10,000	2 x 4	2 x 6	2 x 4
20	10,000	2 x 6	2 x 8	2 x 6
20	16,000	2 x 8	2 x 10	2 x 8

¹ For crate heights of 48 inches and over.

² Size limits of crate. In addition to the 12-foot length and 500-pound gross weight limitations, this crate having 5/8-inch members shall be limited to 4-foot widths and 6-foot heights maximum.

³ Actual thickness of members equals 5/8-inch.

⁴ Crates over 32 feet in length shall be not less than 8 feet in height. Open bolted crates cannot be fabricated in lengths over 32 feet if the height is less than 8 feet. Long crates less than 8 feet high shall be fabricated in accordance with the requirements of Specification MIL-C-104.

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(a) *Side panels.* The design of the side panel is illustrated in figure 6-40. The number of diagonals will depend upon the size of the crate.

(b) *Member selection.* The sizes of the upper, lower, and intermediate longitudinal members are based upon the gross weight and length of the crate as stated in table 6-17.

(c) *Diagonals.* Use $\frac{5}{8} \times 6$ -inch diagonals for crates not exceeding 12 feet in length, four feet in width and six feet in height, with a maximum net load of 500 pounds. Use 1×8 -inch for crates exceeding 32 feet in length and 12 feet in height. Use 1×6 -inch for all other conditions. See table 6-18 for the spacing of the diagonals. One-half of the diagonals shall be nailed to the outside of the longitudinal frame members and the other half shall be nailed to the inside of the same members, sloped in the opposite direction. The points of fastening of the diagonals, except at the end ones, to the longitudinal members shall be the same for inside and outside diagonals to permit the same lag bolts or bolts to pass through both diagonals. At the ends of the upper and lower frame members where no diagonal is present on the inside surface of the member, a filler block 12 inches long, the same thickness as one diagonal and the same width as the frame member, shall be used to provide continuous bearing. The number of diagonals is determined by the spacing of the diagonals.

Table 6-18. Spacing of Diagonals for MIL-C-3774 Crates

Maximum spacing	Thickness of longitudinal members	Crate size	
		Height	Width
Inches	Inches	Feet	Feet
24	2	to 6	to 6
18	2	6-12	6-8
18	2	12-16	to 5
24	1	to 6	to 4
18	1	6-12	4-8

¹ For crates over 32 feet in length.

1. Both inner and outer diagonals shall be nailed to each 2-inch horizontal member with sevenpenny nails in patterns as shown on figure 6-54.

2. The outer diagonals shall be nailed to each 1-inch horizontal member with six nails, three driven from each side, and clinched.

3. The inner diagonals shall be nailed to each horizontal member with sevenpenny nails as shown on figure 6-54. When $\frac{5}{8}$ -inch frame members are used, the nail sizes shall be reduced as required.

(d) *Vertical struts or corner posts.* Fabricate

these members from not less than 3×3 -inch material. These pieces must be continuous from the upper longitudinal frame member of the side to both the lower longitudinal frame member of the side and the end floorboard member.

1. Notch the members when the top of the end floorboard does not come even with the top of the lower longitudinal member of the side.

2. Corner posts or vertical struts are designed to receive the lag bolts from the ends of the crate.

(e) *Corner sheathing.* Locate this material on the outside at each corner of the crate. Boards used at each end of the sides must be at least 1×8 -inch pieces, except when diagonals and are $\frac{5}{8}$ -inch-thick, the sheathing is $\frac{5}{8} \times 8$ -inch material.

1. Nail sheathing boards to the vertical struts and corner posts with two rows (staggered pattern) of ninepenny nails. Space 8 inches apart within each row.

2. Nail sheathing boards to 2-inch longitudinal members with clinched eightpenny nails, five at each joint. Secure to 1-inch longitudinal members with clinched nails. Use pattern shown in figure 6-54.

(3) *Ends.* The ends consist of the upper, lower and intermediate longitudinal members which are the same size as the corresponding members of the sides (fig 6-41).

(a) Intermediate longitudinal members are required only when crates are 48 inches high or higher.

(b) Vertical struts of the ends are one continuous piece.

(c) All diagonal members of the ends are not less than 1×6 -inch material. An X frame pattern is required when the width of the crate is not more than $1\frac{1}{2}$ times the height. When this limit is exceeded, a two-X frame pattern is required.

(d) *Partial sheathing (corner).* The outside vertical sheathing boards are not less than 1×6 -inch for net loads up to 3,000 pounds, and not less than 1×8 -inch boards for net loads over 3,000 pounds. Nail the corner board to the struts with two rows of sixpenny nails (staggered pattern). Space them 8 inches apart in each row and clinch.

(4) *Top panels.* (fig 6-42). Determine the number of panels to use by the length and width of the crate. Place the diagonal frame members as near to 45° angles as possible.

(a) *Frame members.*

1. Use 2×4 -inch (one edge) or 3×3 -inch members for contents up to 4,000 pounds. Over 4,000 pounds, use 4×4 -inch pieces.

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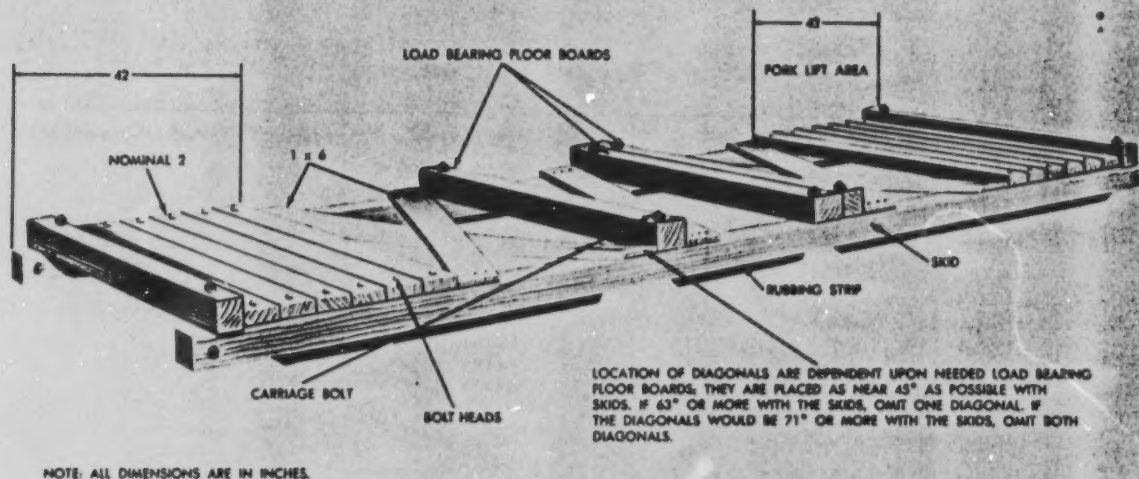


Figure 6-39. Skid base for bolted crate (MIL-C-3774).

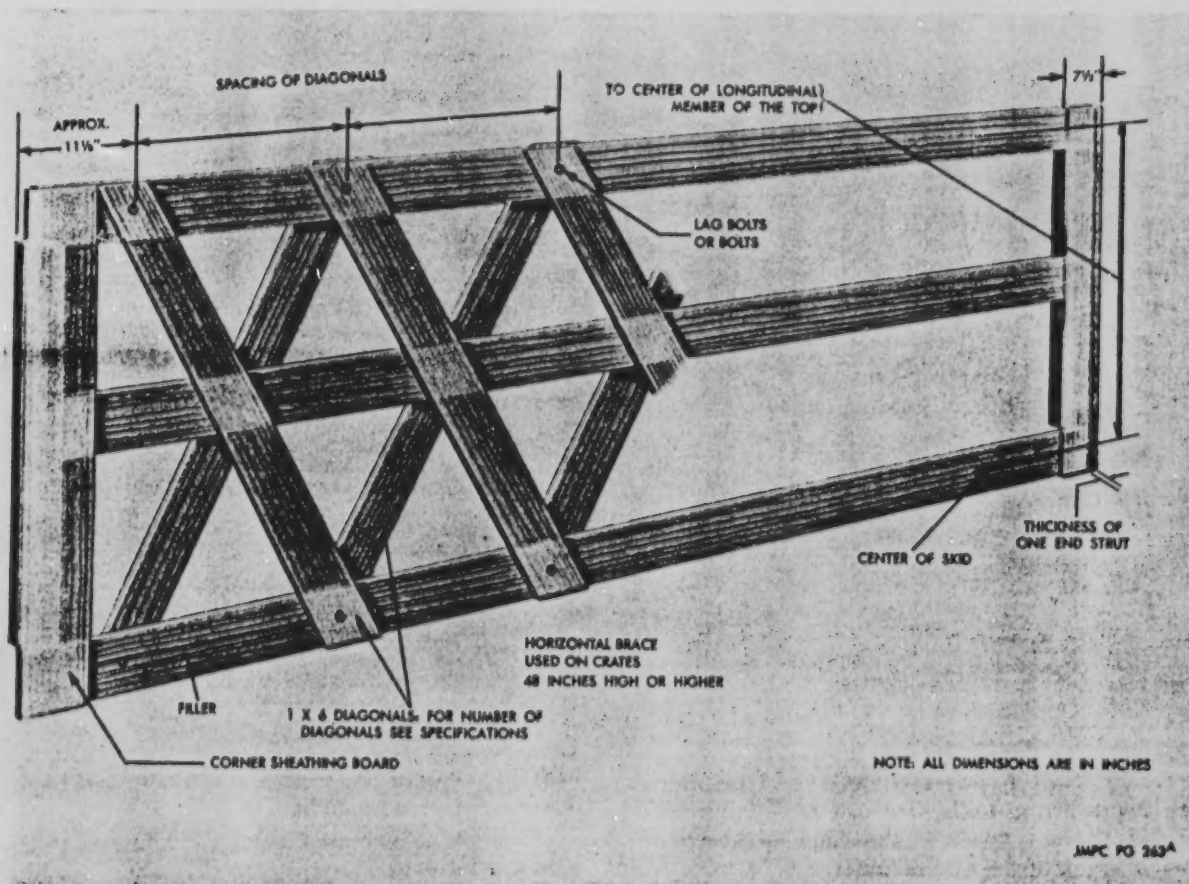
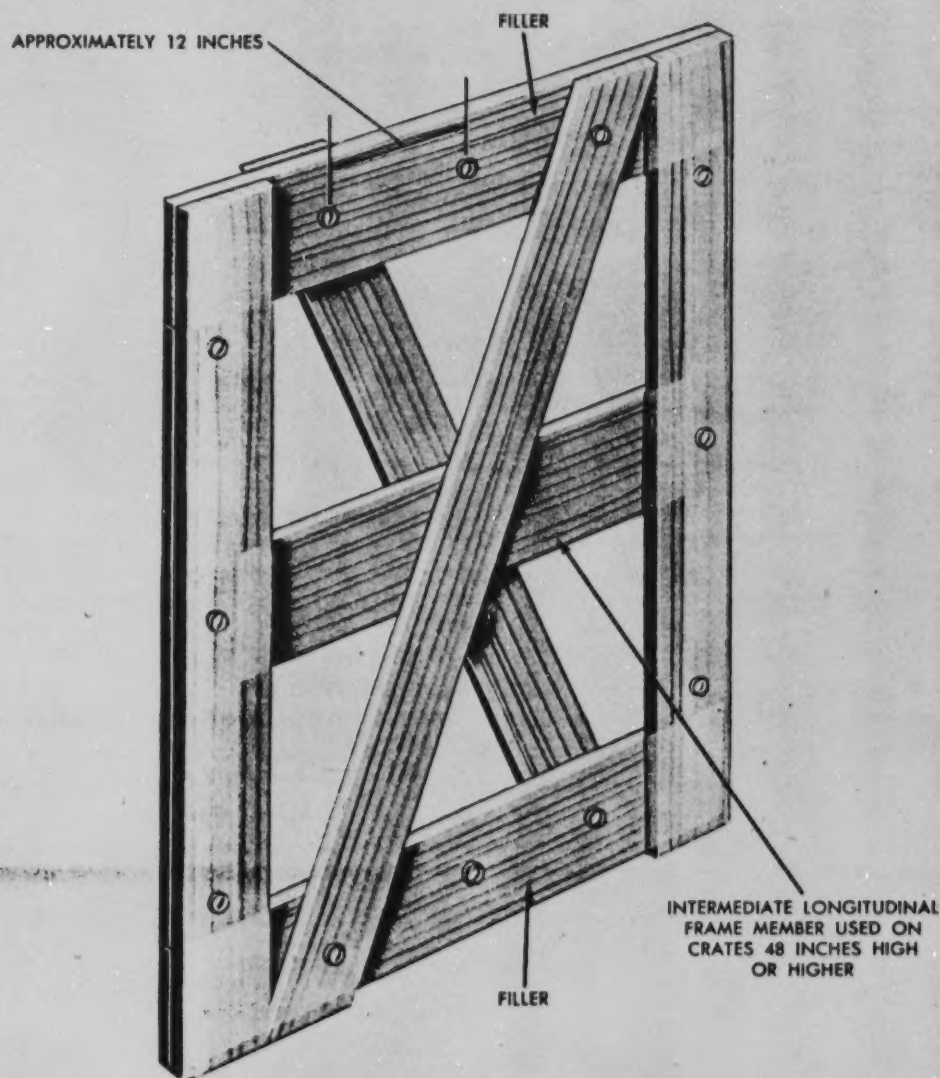


Figure 6-40. Side for bolted crate (MIL-C-3774).

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Figure 6-41. End for bolted crate (MIL-C-3774).

2. Nail 2-inch crosswise end members with twelpenny nails, three at each joint. Nail through the side grain of the edge member into the end grain of the end member.

3. Nail 3 x 3-inch and 4 x 4-inch crosswise end members with twelpenny nails, three at

each joint, toenailed from the edge member into the crosswise end member.

(b) *Diagonal members.* All diagonal members are 1 x 6-inch boards

1. Nail diagonals to longitudinal members with eightpenny nails.

2. Where diagonals cross each other, use sevenpenny nails, five at each crossing, and clinch.

(c) *End sheathing boards.* All end sheathing boards of the top are 1 x 8-inch in size.

1. Nail the end sheathing boards to the frame member of the top with two rows of eightpenny nails spaced 4 inches apart in a single line for 2 x 4-inch frame members. For larger members the nails are staggered.

2. Nail sheathing boards to longitudinal members with eightpenny nails.

(d) *Filler strips.* Fabricate filler strips from 1 x 4-inch material. Place them between the diagonals and nail. This will level the top in order to accommodate superimposed loads. Secure these strips with sixpenny nails spaced 6 inches apart.

(e) *Top joists.* Determine the size of the top joists by the width of the crate and the net weight of contents, as specified in table 6-19. An angle joist shall be placed between the longitudinal frame members and at the center of balance. For long crates or for crates over 10,000 pounds in weight, two sets of joists shall be used and placed not more than 43 inches on each side of the center of balance. Nail through the 2-inch longitudinal

members into the end grain of the top joist with twelvepenny coated nails, three in each joist. For 4-inch joist, use five nails. Toenail joist with twelvepenny coated nails.

c. Assembly of Bolted Crates.

(1) Requirements for lag bolts or bolts.

(a) Lag bolts may be used as fasteners for assembling the various panels of a bolted crate (fig 6-5).

(b) When a single diagonal occurs on the inside of a longitudinal member, use a three-fourths inch shorter lag bolt or bolt.

(c) When the diagonal is on the outside of the frame member, use a 3/4-inch filler strip between the frame member and the member to which the part is being fastened (fig 6-41).

(d) If bolts are used, they must be machine bolts with washers placed under both the head and the nut. Use washers under the heads of all lag bolts.

(e) Space 3/8-inch lag bolts or bolts not more than 24 inches apart. Space 1/2-inch lag bolts or bolts not more than 30 inches apart. Space 5/8-inch lag bolts or bolts more than 36 inches apart.

(2) Assembly of the panels (fig 6-43).

(a) Fastening the sides to the base.

1. The size and number of lag bolts used to fasten the side panels to the base are determined by the weight contents, the wood group used, and the width and thickness of the members as specified in table 6-17. The number of lag bolts or bolts specified in the tables are given for both side panels, one-half the number to be used on each side.

2. Connector plates may be used between the diagonals and skids. When used, use only half the number of lag bolts or bolts specified in tables 6-20 and 6-21. As an example, if the gross load is

Table 6-19. Joist Sizes

Size of joist	Limits	
	Gross load	Length (crate width)
Inches	Pounds	Inches
2 x 4	1,000	72
2 x 4	2,000	60
2 x 4	3,000	48
2 x 4	5,000	36
4 x 4	10,000	96
2 1/2 x 4	16,000	96

¹ Use two joists for greater widths of top.

² Use two joists.

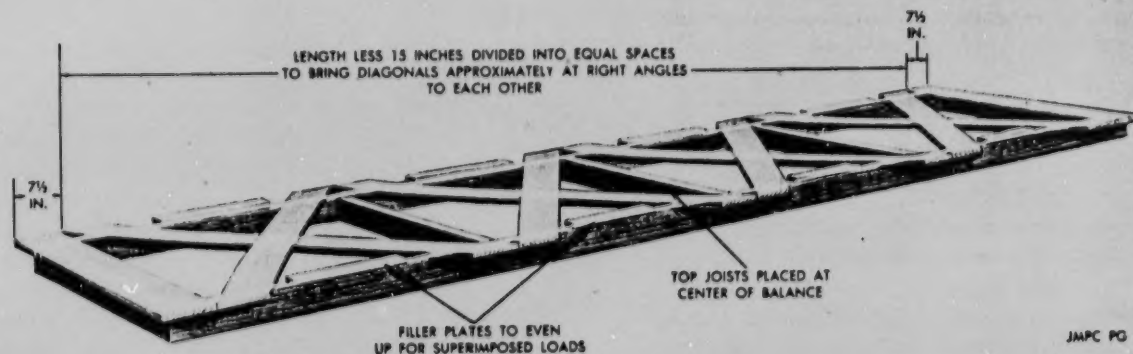


Figure 6-43. Top for bolted crate (MIL-C-3774).

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Table 6-20. Number of Lag Bolts for Assembling Sides to Base of Bolted Crates; Where Nominal 1-inch Longitudinal Members Are Used in Sides and Nominal 4-Inch Wide Skids Are Used

Net weight of load	1/2 by 6 inch lag				1/2 by 5-1/2 inch lag				3/8 by 6 inch lag				3/8 by 5-1/2 inch lag			
	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV
8,000	28	24	22	18	32	28	24	22	32	28	26	22	36	32	30	26
7,000	24	22	18	16	28	24	22	18	28	24	22	20	32	28	26	22
6,000	20	18	16	14	24	20	18	16	24	22	18	16	28	24	22	18
5,000	18	16	14	12	20	18	16	14	20	18	16	14	22	20	18	16
4,000	14	12	10	10	16	14	12	10	16	14	12	10	16	16	14	12
3,000	10	10	8	6	12	10	10	8	12	10	10	8	14	12	10	10
1/2 by 5 inch lag								3/8 by 4-1/2 inch lag								
3,000	18	16	14	12					20	18	16	14				
2,500	14	12	12	10					16	14	12	10				

Note. G refers to the wood group and applies to the skids. If bolts are used, they shall be the same number and diameter as given above for lag bolts.

Table 6-21. Number of Lag Bolts for Assembling Sides to Base of Bolted Crates; Where Nominal 2-Inch Longitudinal Members Are Used in Sides and Nominal 4-Inch Wide Skids Are Used

Net load	5/8 by 7-inch lag				1/2 by 7-inch lag				1/2 by 6-1/2-inch lag				1/2 by 6-inch lag			
	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV
Pounds																
16,000	48	44	36	32	56	48	44	36	64	56	48	44	74	68	60	52
14,000	40	36	32	28	48	44	36	32	56	48	44	36	64	60	52	44
12,000	36	32	28	24	40	36	32	28	48	40	36	32	56	52	44	40
10,000	30	26	24	20	34	30	28	24	40	34	32	26	46	42	38	32
9,000	26	24	22	18	30	28	24	22	36	32	28	24	42	38	34	28
8,000	24	22	18	16	28	24	22	18	32	28	24	22	38	34	32	26
7,000	20	18	16	14	24	22	18	16	28	24	22	18	32	30	28	22
6,000	18	16	14	12	20	18	16	14	24	20	18	16	28	26	22	20
5,000	14	14	12	10	18	16	14	12	20	18	16	14	24	20	18	16
4,000	12	10	10	8	14	12	10	10	16	14	12	10	18	16	14	12
3,000	10	8	8	6	10	10	8	8	12	10	10	8	14	12	12	10

¹ Refers to the wood group and applies to the skids.

Note. If bolts are used, they shall be the same number and diameter as given for lag bolts.

8,000 pounds, use the number of bolts required in tables for 4,000 pounds.

3. Use the correct diameter and length of fasteners specified in tables 6-20 or 6-21, through each pair of diagonals, through the lower longitudinal member of the side, and into the sides of the skids.

(b) Fastening the side panels to the top.

1. Determine the size and number of lag bolts or bolts used to fasten the side panels to the top from the thickness of the diagonals and top frame members of the side, and the width of the longitudinal frame member of the top.

2. Use 1/2-inch lag bolts or bolts when the combined thickness of the diagonals, the upper edge member of the side, and the longitudinal member of the top, is 4 3/4 inches or more; use 3/8-inch fasteners when the sum is less.

3. The length of the lag bolt should be approximately equal to the sum of the three or four thicknesses. Bolts should be long enough to accommodate the nut and washers (under head and nut).

4. Secure the side panel to the top by using a lag bolt or bolt through each pair of diagonals and upper longitudinal member of the side, and into the longitudinal member of the top. This is required around the perimeter of the crate (fig 6-5).

(c) Fastening the end panels. The diameter and length of the lag bolts or bolts for fastening the ends of the crate to the top, bottom, and sides, is determined in a manner similar to that for fastening the sides to the top.

1. End panels to the top. The size and length of fastener will depend upon the thickness

of one or two diagonals or fillers, the top horizontal frame member of the end, and the width of the crosswise frame member to the top.

2. *End panels to the base.* The size and length of fasteners for securing the end panels to the base is the same as above.

3. *End panels to the side panels.* The size and length of fasteners to secure the end panels to the side panels is as specified for fastening the sides to the top. For $\frac{3}{8}$ -inch frame in the end, for loads not exceeding 500 pounds, use $\frac{3}{16}$ -inch diameter lag screws or bolts.

(d) *Corner strapping.* Use corner strapping on all nailed and bolted crates carrying a net load of 3,000 pounds or over, to reinforce the corners and to reinforce the crate at the junction of the panel (fig 6-4).

1. Fabricate all corner straps from $1\frac{1}{4}$ x .035-inch steel banding, 12 inches in length.

2. Apply three steps on each of the four upper corners of the crate and secure to the frame members with sixpenny nails, four in each leg of the strap. Space approximately 2 inches center to center.

3. Apply single straps at 36-inch intervals from the corners in all directions and nail to the frame members.

6-14. Open Nailed Crates (MIL-C-3774)

a. *Design Requirements.* Nondemountable crates may be designed with either a sill- or skid-type base, depending upon the requirements for the item being packed.

(1) *Skid bases.* Skid bases for open nailed crates are constructed almost identical to the bases used for bolted crates (fig 6-39).

(a) *Skids and rubbing strips.* The requirements for skids and rubbing strips are found in paragraph 6-31b(1). The size of skids depends upon the net load and the length of the crate (table 6-22).

Table 6-22. Skid Sizes for Nailed MIL-C-3774 Crates

Maximum net load	Maximum length of crate	Size of skids
Pounds	Feet	Inches
500	12	2 x 4
2,000	12	3 x 3
10,000	16	4 x 4
12,000	16	4 x 6 (on edge)

(b) *Headers.* Headers are bolted to the skids with carriage bolts. The sizes of end headers and bolt sizes are as follows:

Skid size (inches)	Header size (inches)	Bolt diameter (inch)
2 x 4	2 x 4	$\frac{3}{8}$
3 x 3	3 x 3	$\frac{3}{8}$
4 x 4	4 x 4	$\frac{1}{2}$
4 x 6 (on edge)	4 x 4	$\frac{1}{2}$

1. Set the headers or end floorboards back from the ends of the skids the thickness of the end sheathing.

2. When necessary, notch the headers at their ends down flush with the top of the floorboards. These notches will then accommodate and support the lower edge members of the sides.

3. Extend the headers to the outside faces of the outer skids.

4. The end of the base will be similar to the base of the MIL-C-104 crate (fig 6-53).

(c) *Load bearing floorboards.* See table 6-IV for sizes and paragraph 6-13b(1) (d) for requirements.

(d) *Forklift area.* Refer to the requirements stated in paragraph 6-13b(1) (e).

(e) *Nonload bearing floorboards (diagonals).* Refer to the requirements stated in paragraph 6-13b(1) (f).

(2) *Sill bases.* Sill bases are designed for loads to be transmitted to the sides by means of intermediate sills or by the end sills. The size of the side sills is based upon the weight of the contents and the length of the crate. However, sill spacing shall not exceed 48 inches center to center, whether required for transmitting loads or for bracing (fig 6-44).

(a) *Side and end sills.* The size of the side sills is obtained from table 6-23. End sills are the same size as the side sills.

1. Overlap the side sills over the end sills and nail at the corners using twentypenny coated nails.

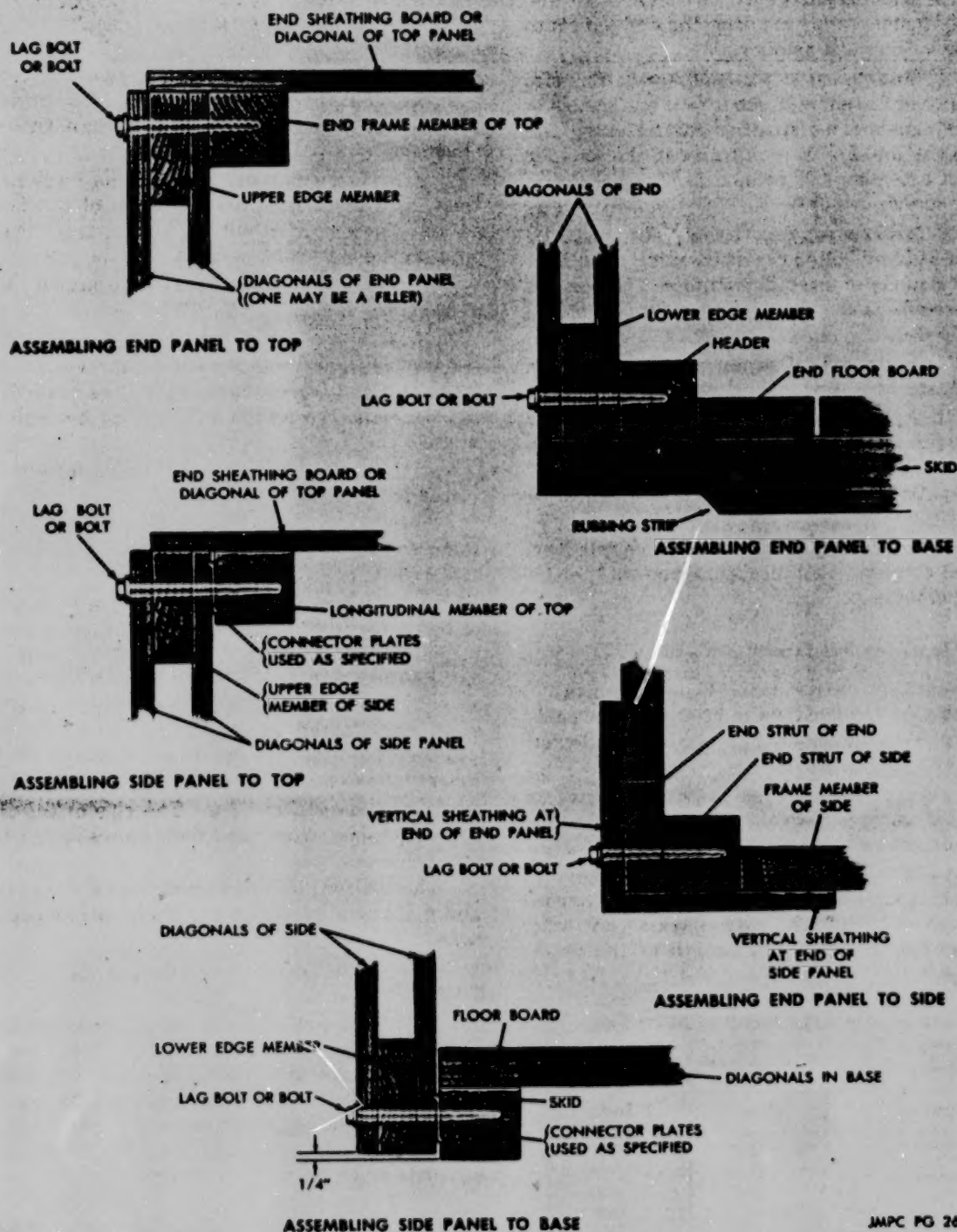
2. When necessary, laminate the sills (fig 6-51).

(b) *Intermediate sills.* Apply intermediate sills either crosswise or lengthwise of the crate. These members are always required when the width of the crate exceeds 48 inches. Determine the size by the length of the sill and the actual weight supported by the sill. Refer to table 6-33 to calculate the intermediate sill size.

1. Attach intermediate sills at their ends to the side or end sills by a combination of nailing and metal hangers (strap or stirrup) (fig 6-17).

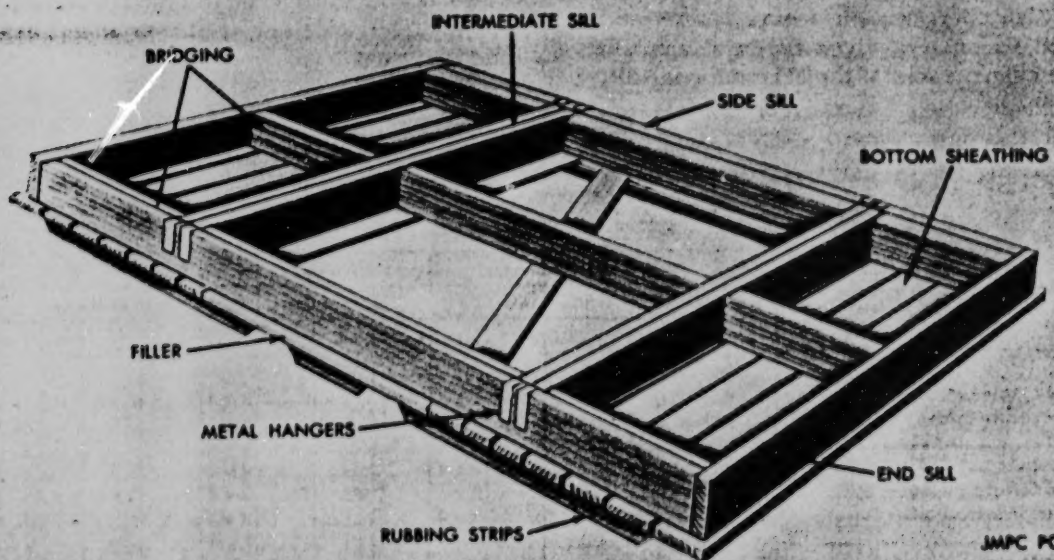
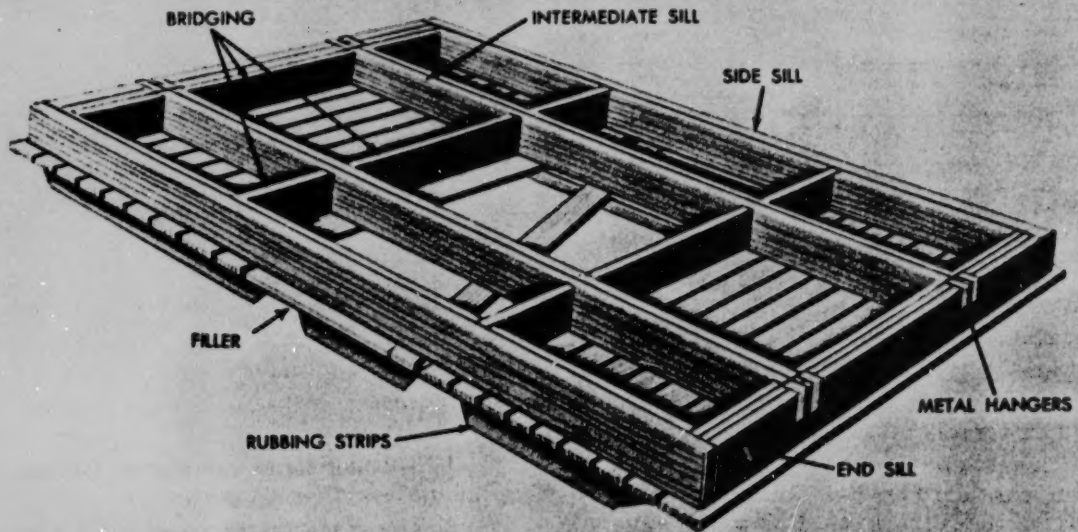
2. Metal hangers are not required for fastening nonload bearing intermediate sills.

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JMPC PG 266A

Figure 6-43. Assembly details for bolted crates (MIL-C-3774).



JMPC PG 267 A

Figure 6-44. Sill base for nailed crate (MIL-C-3774).

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Table 6-23. Size of Side and End Sills

Net weight of contents Pounds	Height in feet	Length of crate (feet)			
		4	8	12	16
2,500 to 4,000	Over 3	2 x 4	2 x 4	2 x 6	2 x 6
	3 or under	2 x 8	2 x 8	2 x 6	2 x 6
4,001 to 6,000	Over 3	2 x 4	2 x 6	2 x 6	2 x 6
	3 or under	2 x 8	2 x 6	2 x 6	2 x 6
6,001 to 8,000	Over 3	2 x 6	2 x 6	2 x 6	2 x 8
	3 or under	2 x 6	2 x 6	2 x 6	2 x 10
8,001 to 10,000	Over 3	2 x 6	2 x 8	2 x 8	2 x 8
	3 or under	2 x 6	2 x 10	2 x 10	2 x 10
10,001 to 12,000	Over 3	2 x 8	2 x 8	2 x 10	2 x 10
	3 or under	2 x 10	2 x 10	2 x 12	2 x 12

(c) *Bridging.* Use bridging to prevent the sills from buckling and to strengthen the base.

1. Bridge intermediate sills at their ends, except when positioned on their flat faces, with 1-inch lumber of the same depth. Nail to the inner face.

2. Reinforce spans 5 feet or over (either length or width of the crate) with 2-inch lumber the same depth as the sills. Position the reinforcing members at right angles to the sills.

(d) *Bottom sheathing.* Position bottom sheathing and nail crosswise to the base (at right angles to the direction of the side sills). Space the boards one-fourth to three-eighths inch apart for drainage.

1. Use boards 4 to 10 inches wide.

2. For the forklift area (42 in. from each end of the base) use 2-inch lumber.

3. Use one piece sheathing boards and extend them one-half to five-eighths of an inch beyond the outside faces of the side and end sills.

4. Place at least one diagonal in the unsheathed portion of the base.

(e) *Rubbing strips.* Position rubbing strips

lengthwise to the crate under each longitudinal sill.

1. Rubbing strips are always two inches thick and not less than 4 inches wide.

2. The clear distance between rubbing strips should not exceed 30 inches.

3. Cut sling notches 8 inches long in each end of the rubbing strip.

4. Use filler strips in the unsheathed area between the sill and the rubbing strip where voids occur.

(3) *Sides.* The sides consist of upper and lower frame members, vertical struts, horizontal braces, diagonals, and gusset plates (fig 6-45).

(a) *Design of the side panels.* Determine the design of the side panel from the inside length and inside height of the crate. For crates up to 48 inches inside height use an X-type frame and for crates with an inside height of over 48 inches use a HK-type frame.

(b) *Member selection.* Determine the sizes of the upper and lower members, struts, and diagonals from tables 6-24 and 6-25 with the exception of the end strut or corner post. Loads referred to

Table 6-24. Panel Member Selection (6,000, 8,000, and 10,000 Pounds Net Load)¹

Length Feet	Members	Net load Pounds	4-foot width				6-foot width				8-foot width			
			Height (feet)				Height (feet)				Height (feet)			
			2	4	6	8	2	4	6	8	2	4	6	8
6	Upper frame member	6,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame members	6,000				2 x 4				2 x 4				2 x 4
	Struts	6,000				2 x 4				2 x 4				2 x 4
	Diagonals	6,000				2 x 4				2 x 4				2 x 4
8	Upper frame member	6,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	6,000				2 x 4				2 x 4				2 x 4
	Struts	6,000				2 x 4				2 x 4				2 x 4
	Diagonals	6,000				2 x 4				2 x 4				2 x 4
10	Upper frame member	6,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	6,000				2 x 4				2 x 4				2 x 4
	Struts	6,000				2 x 4				2 x 4				2 x 4

Table 6-24. Panel Member Selection (6,000, 8,000, and 10,000 Pounds Net Load)¹—Continued

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Length	Members	Net load	4-foot width				6-foot width				8-foot width			
			Height (feet)				Height (feet)				Height (feet)			
			2	4	6	8	2	4	6	8	2	4	6	8
Feet		Pounds												
12	Diagonals	6,000				2 x 4				2 x 4				2 x 4
	Upper frame member	6,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	6,000				2 x 4				2 x 4				2 x 4
	Struts	6,000				2 x 4				2 x 4				2 x 4
16	Diagonals	6,000				2 x 4				2 x 4				2 x 4
	Upper frame member	6,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	6,000				2 x 4				2 x 4				2 x 4
	Struts	6,000				2 x 4				2 x 4				2 x 4
6	Diagonals	6,000				2 x 4				2 x 4				2 x 4
	Upper frame member	8,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	8,000				2 x 4				2 x 4				2 x 4
	Struts	8,000				2 x 4				2 x 4				2 x 4
8	Diagonals	8,000				2 x 4				2 x 4				2 x 4
	Upper frame member	8,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	8,000				2 x 4				2 x 4				2 x 4
	Struts	8,000				2 x 4				2 x 4				2 x 4
10	Diagonals	8,000				2 x 4				2 x 4				2 x 4
	Upper frame member	8,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	8,000				2 x 4				2 x 4				2 x 4
	Struts	8,000				2 x 4				2 x 4				2 x 4
12	Diagonals	8,000				2 x 4				2 x 4				2 x 4
	Upper frame member	8,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	8,000				2 x 4				2 x 4				2 x 4
	Struts	8,000				2 x 4				2 x 4				2 x 4
16	Diagonals	8,000				2 x 4				2 x 4				2 x 4
	Upper frame member	8,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	8,000				2 x 4				2 x 4				2 x 4
	Struts	8,000				2 x 4				2 x 4				2 x 4
6	Diagonals	8,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
8	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
10	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
12	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
16	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
10	Diagonals	10,000	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 6
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
12	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
16	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
10	Diagonals	10,000	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 6
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
12	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
16	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
10	Diagonals	10,000	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 4	1 x 6	1 x 6	1 x 6	2 x 6
	Upper frame member	10,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
12	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4	2 x 6	2 x 4	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4
16	Diagonals	10,000				2 x 4				2 x 4				2 x 4
	Upper frame member	10,000	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4	2 x 8	2 x 6	2 x 4	2 x 4
	Lower frame member	10,000				2 x 4				2 x 4				2 x 4
	Struts	10,000				2 x 4				2 x 4				2 x 4

¹ All blank spaces are 1 x 4's.

Note. See text for size of end struts of sides.

in the table are based on the net weight of the contents and the inside dimensions of the crate. If the exact size of the crate is not given in the table, use the member size for the crate of the next longer length, the next greater width, and next smaller height.

1. Use 1 x 4-inch lumber for members and diagonals and 2 x 4-inch lumber for upper edge

members when the height of the crate is 6 feet or less and the load does not exceed 4,000 pounds.

2. Use 1-inch lumber for the lower edge members, struts and diagonals, and 2-inch lumber for the upper edge members and end struts when the height of the crate is under 6 feet and the load is over 4,000 pounds.

3. Use 2 x 4-inch lumber for the upper and

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Table 6-25. Panel-Member Selection (12,000 Pound Net Load)¹

Length	Members	Net load	4-foot width			6-foot width			8-foot width		
			Height (feet)			Height (feet)			Height (feet)		
			4	6	8	4	6	8	4	6	8
Feet		Pounds									
6	Upper frame member	12,000									
	Lower frame member	12,000									
	Struts	12,000									
	Diagonals	12,000			(*)			(*)		(*)	(*)
8	Upper frame member	12,000									
	Lower frame member	12,000									
	Struts	12,000									(*)
	Diagonals	12,000		(*)	2 x 6		(*)	2 x 6		(*)	2 x 6
10	Upper frame member	12,000									
	Lower frame member	12,000									
	Struts	12,000						(*)			2 x 6
	Diagonals	12,000		2 x 6	2 x 6		2 x 6	2 x 6		2 x 6	2 x 6
12	Upper frame member	12,000									
	Lower frame member	12,000									
	Struts	12,000						2 x 6		2 x 6	2 x 6
	Diagonals	12,000			2 x 6		2 x 6	2 x 6		2 x 6	2 x 6
16	Upper frame member	12,000									
	Lower frame member	12,000									
	Struts	12,000						2 x 6			2 x 6
	Diagonals	12,000			2 x 6			2 x 6	2 x 6	2 x 6	2 x 6

¹ All blank spaces are 2 x 4's.

* Note. The above sizes are for uniform loads but apply also to concentrated loads where an asterisk is shown. When an asterisk is shown, increase the member size to 2 x 6 for concentrated load.

lower edge members, struts and diagonals, when the height of the crate is over 6 feet.

(c) *Upper, lower, and intermediate members.* The members are required to be a single continuous piece. If splicing is required, splice the members according to the details shown in figure 6-50. All splicing should be made under or over a strut whenever possible. Splicing 1-inch material is not permitted. The size of these members is based upon the gross weight and length of the crate. Intermediate members (horizontal braces) are used only for crates of the HK type.

(d) *Vertical struts and diagonals.* All vertical struts and diagonals are continuous from the lower frame member to the upper frame member. Cut the diagonal and horizontal braces to fit between the vertical struts.

(e) *End struts or corner posts.* The end vertical strut or corner post of the side is not less than 2 inches in thickness in order to provide sufficient nailing space when fastening the ends.

(f) *Partial sheathing boards.* Always apply the sheathing boards vertically. These boards are located at the corners and at various intervals based upon the design of the crate.

1. *Lumber sheathing.* The sheathing boards are of one piece material, 1 inch thick, and from 4 to 10 inches wide. All end boards are at least 6 inches wide, preferably wider. Ten percent

of the boards may be 4 inches wide, but no narrow boards may be adjacent to each other.

2. *Plywood sheathing.* Plywood strips, three or five ply material, may be substituted for lumber sheathing in the sides, ends, or tops. This material must be the same width as the lumber sheathing. For loads up to 5,000 pounds, use $\frac{7}{16}$ inch plywood of group I woods; $\frac{3}{8}$ -inch of group II woods; $\frac{5}{16}$ -inch of group III and IV woods. For loads over 5,000 pounds, use $\frac{1}{2}$ -inch plywood of group I woods; $\frac{7}{16}$ -inch of group II woods; $\frac{3}{8}$ -inch of group III and IV woods.

(g) *Gusset plates.* Gusset plates are required for crates using 1-inch frame members. Place the gusset plates where the diagonals, struts, or horizontal braces intersect. Plywood gusset plates are not required when plywood sheathing is used. Use 12 x 12 x $\frac{1}{4}$ -inch gusset plate for 1 x 4-inch frame members. Use 18 x 18 x $\frac{1}{4}$ -inch gusset plate for 1 x 6-inch frame members. Secure the gusset plates to frame members using sevenpenny nails and clinch (fig 6-56).

(h) *Nailing lumber sheathing.* Nail 4 to 6 inches wide sheathing boards of horizontal and diagonal members with three rows of ninepenny clinched nails. Use three nails in sheathing boards 4 to 6 inches wide and four nails in wider boards. Nail sheathing boards over 6 inches wide to horizontal and diagonal members with four rows of

ninepenny clinched nails. Nail sheathing boards 4 to 6 inches wide to vertical struts with two rows of ninepenny nails, spaced 6 inches apart in each row and clinch.

(i) *Nailing plywood sheathing.* Nail plywood sheathing to 4-inch wide frame members with two rows of nails, spaced 6 inches apart in each row, and clinch. Use three rows of nails in frame members over 4 inches wide. The nailing requirements are identical to those illustrated in figure 6-54 except for the spacing.

(4) *Ends.* The end frame members are identical to those of the sides. The design of the end panels is also based upon the inside length and inside height of the crate. The panel design will be either X or HK framing (fig 6-45).

(a) *Member selection.* The frame members of the ends are the same size as the corresponding members of the sides.

(b) *Nailing (para 6-14a93)(h) and (i).*

(5) *Top panels.* The top panels consist of framing members, partial sheathing boards, gusset plates and joists. Tops are classified according to types (table 6-26 and fig 6-46).

Table 6-26. Type of Tops (MIL-C-3774)

Type framing pattern	Width of top (in.)
N -----	Up to 40
X -----	Over 40 through 60
HK -----	Over 60 through 96

(a) *Number of panels.* To determine the number of panels for N, X or HK type of top, divide the crate length by the crate width and use the nearest whole number.

(b) *Frame members.* All top frame members are 1 x 6-inch material. When the width of the top is 24 inches or less use 1 x 4-inch material.

(c) *Gusset plates.* Use gusset plates at the intersection of the frame members of the top. They are the same size and nailed in the same manner as those for the side and end panels (para 6-14a(3) (g)).

(d) *Top joists.* Determine the size of the joists by the weight of the contents and the length of the joists (table 6-19). Space the joists not more than 48 inches center to center. Extend all joists from the upper longitudinal member of one side to the upper longitudinal member of the other side. Fasten each joist with three twelpenny coated sinkers through the upper edge members of the side into the end of the joist when the framing is one inch thick. Use three twentypenny nails per

joint for 2-inch upper frame members. This nailing is accomplished as the crate is being assembled.

b. *Fabrication of Open Nailed Crates.*

(1) *Sheathing to the horizontal and diagonal frame members.* Use nails for securing the sheathing to the frame members (up to and including 2-in. thickness) long enough to permit clinching at least one-fourth of an inch. Use three rows of nails to secure the sheathing. Use a minimum of three nails in each sheathing board up to 6 inches wide. Use not less than four nails in wider boards.

(2) *Sheathing to the vertical frame members.* Use two rows of nails, placed on 6-inch centers, in each row and stagger (table 6-28 and fig 6-46).

(3) *Plywood sheathing to the frame members.* The nails for fastening plywood to framing members shall be long enough to pass through the plywood and the frame member and be clinched not less than one-fourth of an inch. Stagger all nails in two parallel rows in each frame member up to $3\frac{3}{8}$ inches wide, and in three rows in wider frame members. Place the nails not less than one-half of an inch from the edge of the frame members. The distance between rows of nails is not less than one inch, and the distance between adjacent nails in any row is not to exceed 6 inches.

(4) *Sheathing to the side frame members of the top.* Use two rows of nails. One row three-fourths inch from the inside edge of the frame member, and one row three-fourths of an inch from the outside edge. Stagger the nails between rows with a minimum of two clinched nails in each sheathing board at each longitudinal member.

(5) *Sheathing to the end frame members of the top.* Place one row of nails in three-fourths of an inch from the inside edge of the frame member. Place the other row in the center of the frame members. Space the nails 9 inches apart in each row and clinch.

(6) *Sheathing to the longitudinal and diagonal members of the top.* Use three rows of nails, with not less than three nails in sheathing boards 6 inches wide. Use not less than four nails in wider boards.

(7) *Sheathing to the struts of the top.* Two rows of nails are required not less than three-fourths inch from the edges of both the frame members and the sheathing. Space the nails on 9-inch centers in each row and clinch.

(8) *Plywood sheathing to the frame members of the top.* If plywood is substituted for lumber, stagger the nails in two parallel rows and space them 6 inches apart in each row. Position the nails

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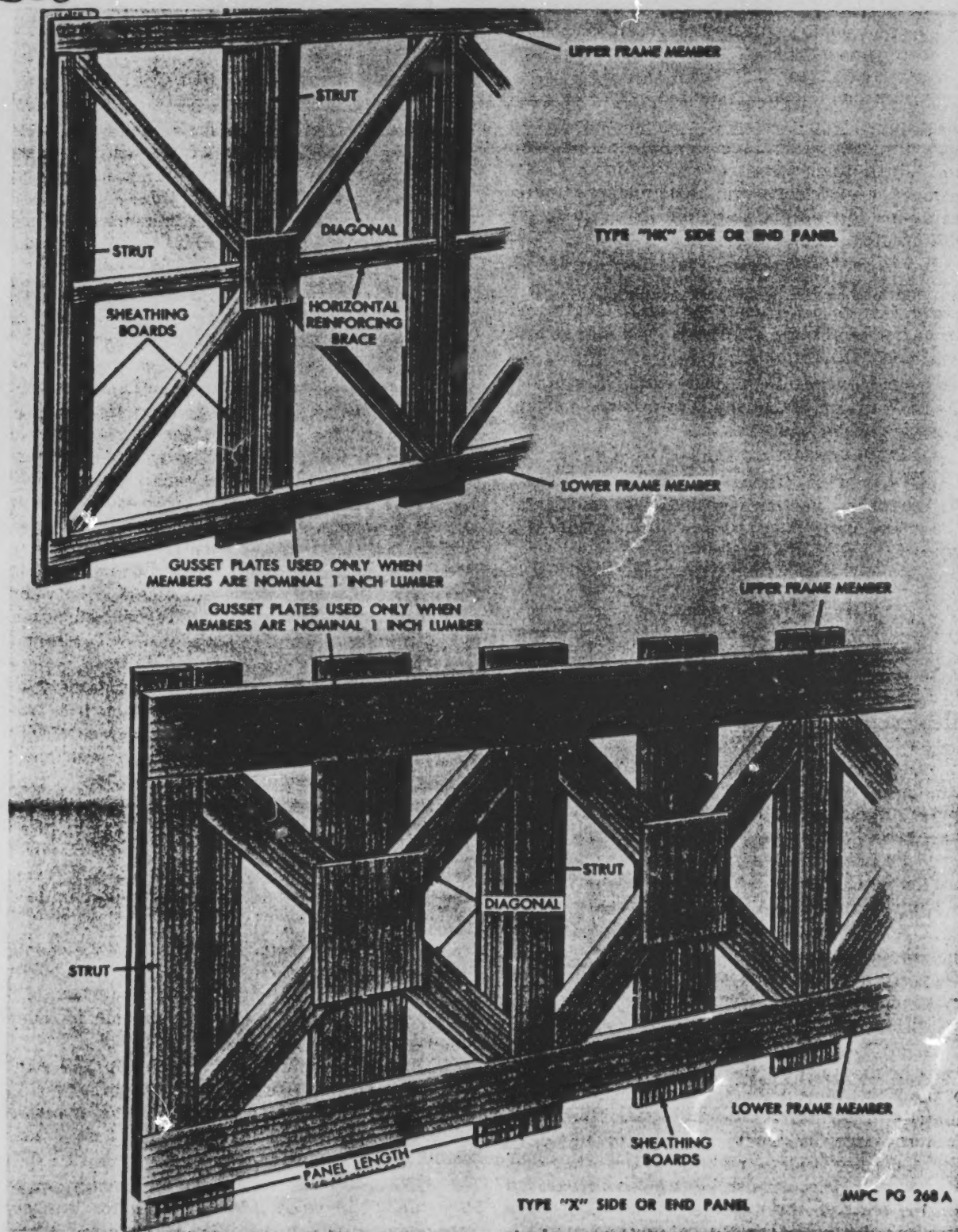


Figure 6-45. Side or end panel for nailed crate (MIL-C-3774).

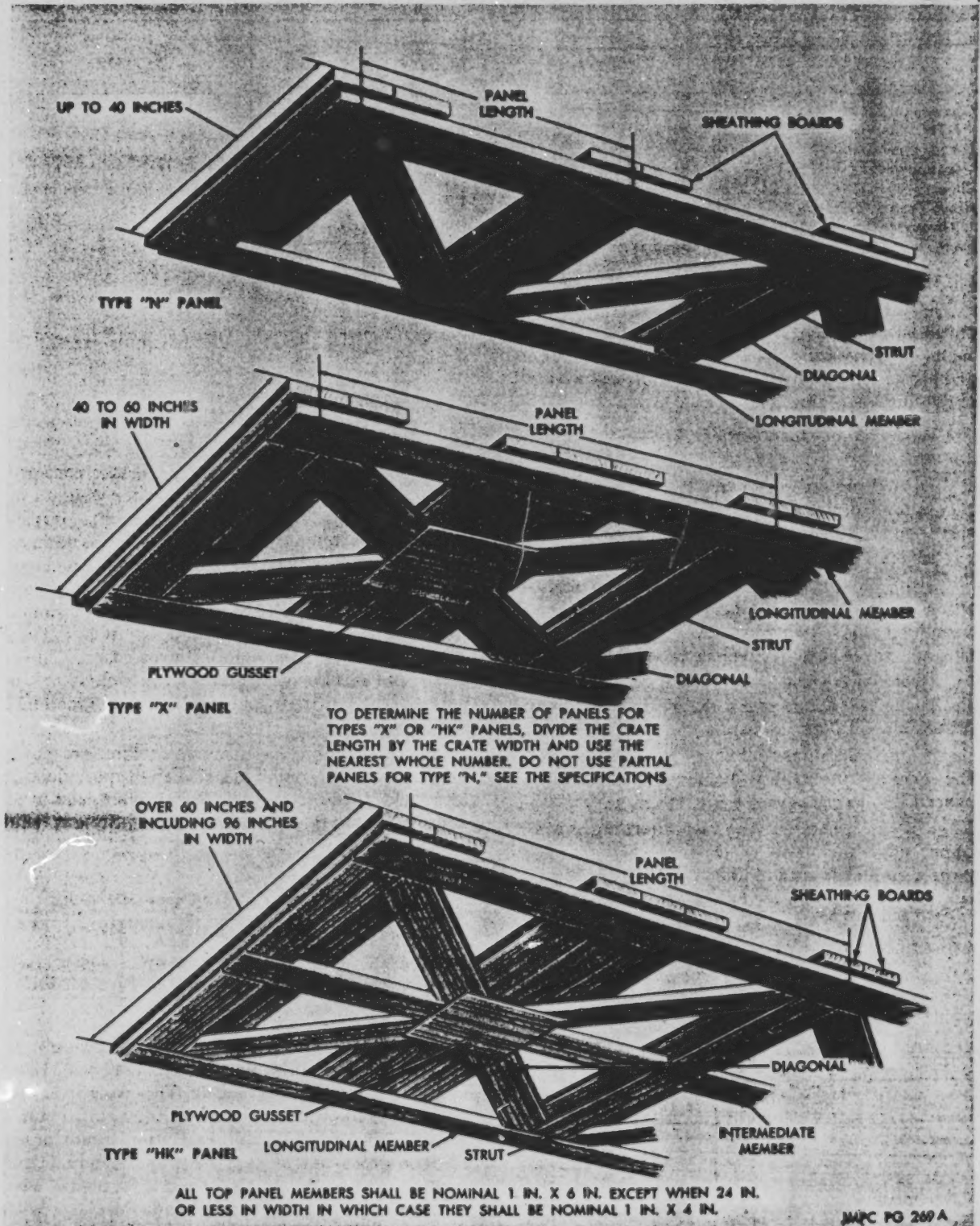


Figure 6-46. Types of top panels (MIL-C-3774).

Table 6-27. Nailed Crate Assembly (MIL-C-3774).

Fasten		Size type of nail	Maximum spacing	Notes
Part	To part			
Corner strut of end— (1-inch member).	Corner strut of the side -----	12d	Inches 12	Predrill through sheathing of end and corner strut of end. Stagger.
Corner strut of end— (2-in. member).	Corner strut of the side -----	20d	12	
Sheathing of side -----	Corner strut of the end -----	8d	6 to 8	
Edge frame member of top— (through sheathing).	Upper framemember of sides -----	12d	6 center to center.	
Edge frame member of top -----	Upper frame member of sides -----	8d	6 to 8	Space nails between top sheathing.
End strut of top -----	Upper frame member of end -----	12d	6	Stagger.

three-fourths inch from the edge of the frame members. The nails must be long enough to penetrate both the members and be clinched at least three-fourths of an inch.

c. Assembly of Open Crates (fig 6-4, 6-47 and 6-48).

(1) *Nailing requirements.* The nailing requirements for fastening the base, sides, ends, and top together are found in tables 6-27 and 6-28.

(2) *Nailing procedures.*

(a) When attaching the sides and ends to the skids, use one row of nails (staggered) for 2-inch-deep skids, two rows for 3- and 4-inch-deep sills and three rows for deeper members.

(b) Secure the corner struts of the end to the corner struts of the side with twentypenny nails spaced 12 inches apart.

(c) Nail the partial sheathing of the side to the corner strut of the end using eightpenny nails, spaced 6 to 8 inches apart, and staggered.

(d) Nail through the top sheathing into the upper edge members of the side using twelvepenny nails, spaced 6 inches apart, center to center.

(e) Nail the top sheathing to the top joists using twelvepenny nails, spaced 8 inches apart.

Table 6-28. Nails Per Each 1,000-Pound Gross Load; Nailing Side Sheathing to Skids or Sills and End Sheathing to Headers and Sills

Nail Type	Wood groups of skids			
	Penny size	II	III	IV
Common -----	7	20	21	16
Do -----	8 or 9	16	17	13
Do -----	10	13	14	11
Sinker or cooler -----	7	23	26	19
Sinker or cooler -----	8 or 9	19	21	16
Sinker or cooler -----	10	18	19	14
Corker -----	8 or 9	17	19	14
Do -----	10	15	16	12

(3) *Corner strappings* (para 6-13c (2) (d) and fig 6-4 and 6-18.

6-15. Sheathed Wood Crates, MIL-C-104 (General)

a. *Crate Design.* Fully sheathed crates conforming to Specification MIL-C-104 are for weights up to 30,000 pounds. These crates are used to provide protection to items that are susceptible to damage from outside forces, or for items that are too large or too heavy to fall within the weight and dimensional limitations of an open crate or a nailed wood box. Usually items shipped in sheathed crates need this additional protection. These crates are designed to support the weight of the item only when their ends and sides are fastened in place.

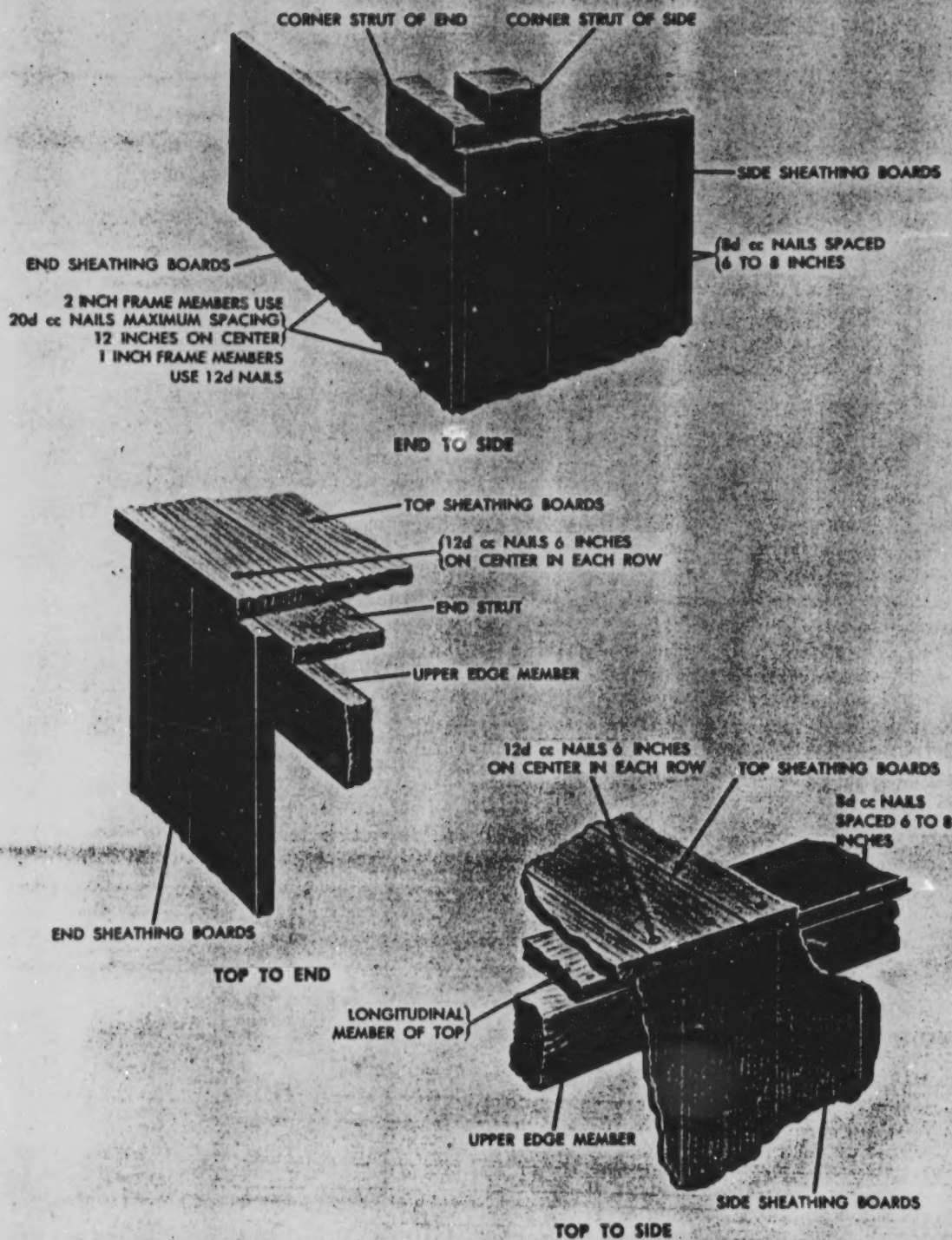
b. *Classification.* Eight crate designs are possible through the combination of the types, classes, and styles given in table 6-29. For example, a type I (nailed), class 2 (plywood sheathed), Style A (skid base) crate may be used.

Table 6-29. Classification of Crates (MIL-C-104)

Types	Classes	Styles
I (Nailed) -----	1 (Lumber sheathed)	a (Skid base)
II (Bolted) -----	2 (Plywood sheathed)	b (Sill base)

(1) *Weight limitations.* The gross weight of these crates should not be more than 11,200 pounds, whenever practicable. This weight is recommended in order to permit handling with ship's gear. However, when this limitation is not possible, the gross weight may be greater than 11,200 pounds but less than 20,000 pounds for crates with Style b (sill) bases, or 30,000 pounds for crates with Style a (skid) bases.

(2) *Dimension limitations.* The exterior dimensions of the crate are limited to 30 feet in



NOTE: CC = CEMENT COATED

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Figure 6-47. Assembly of open nailed crates.

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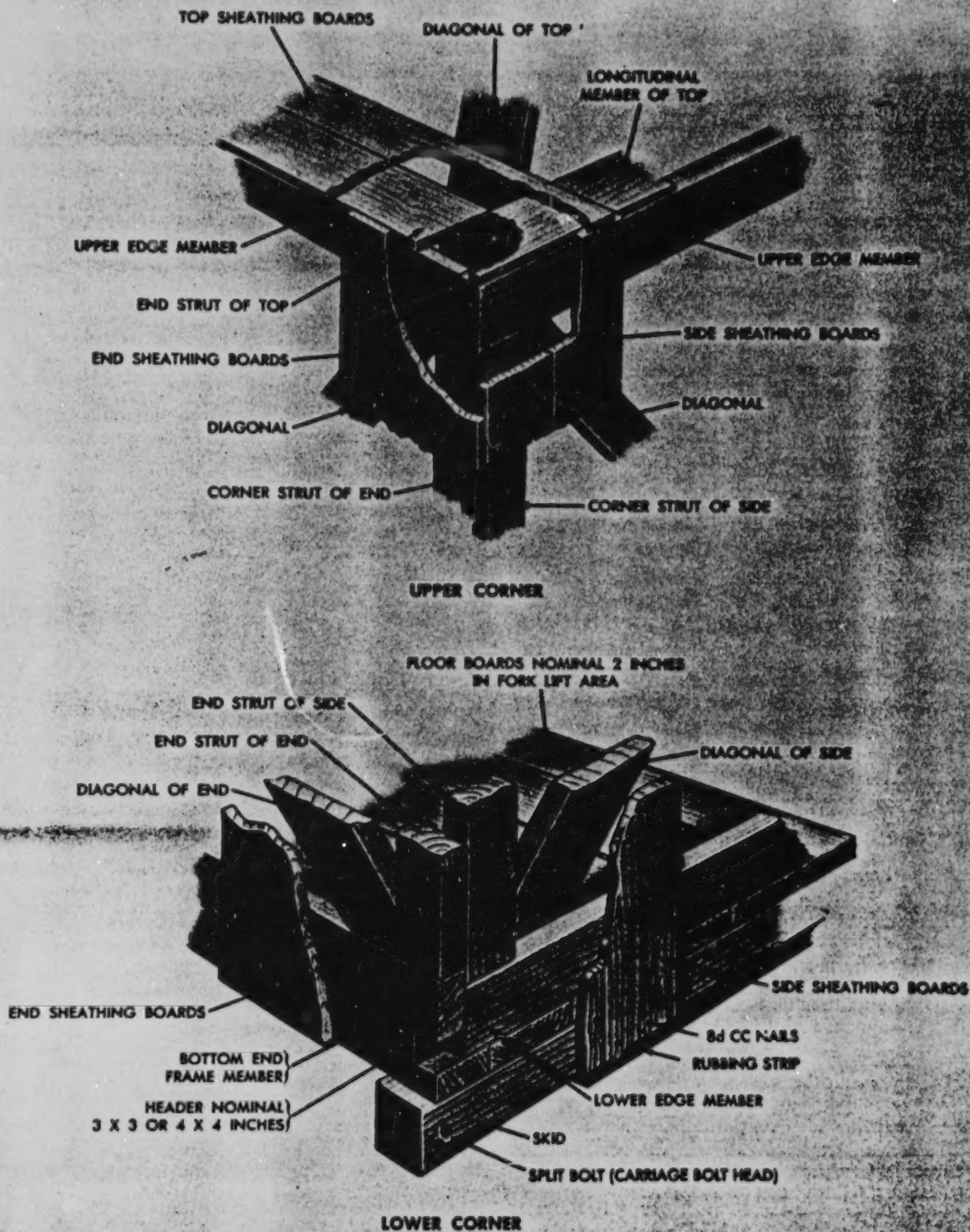


Figure 6-48. Assembly details for nailed crates (MIL-C-8774).

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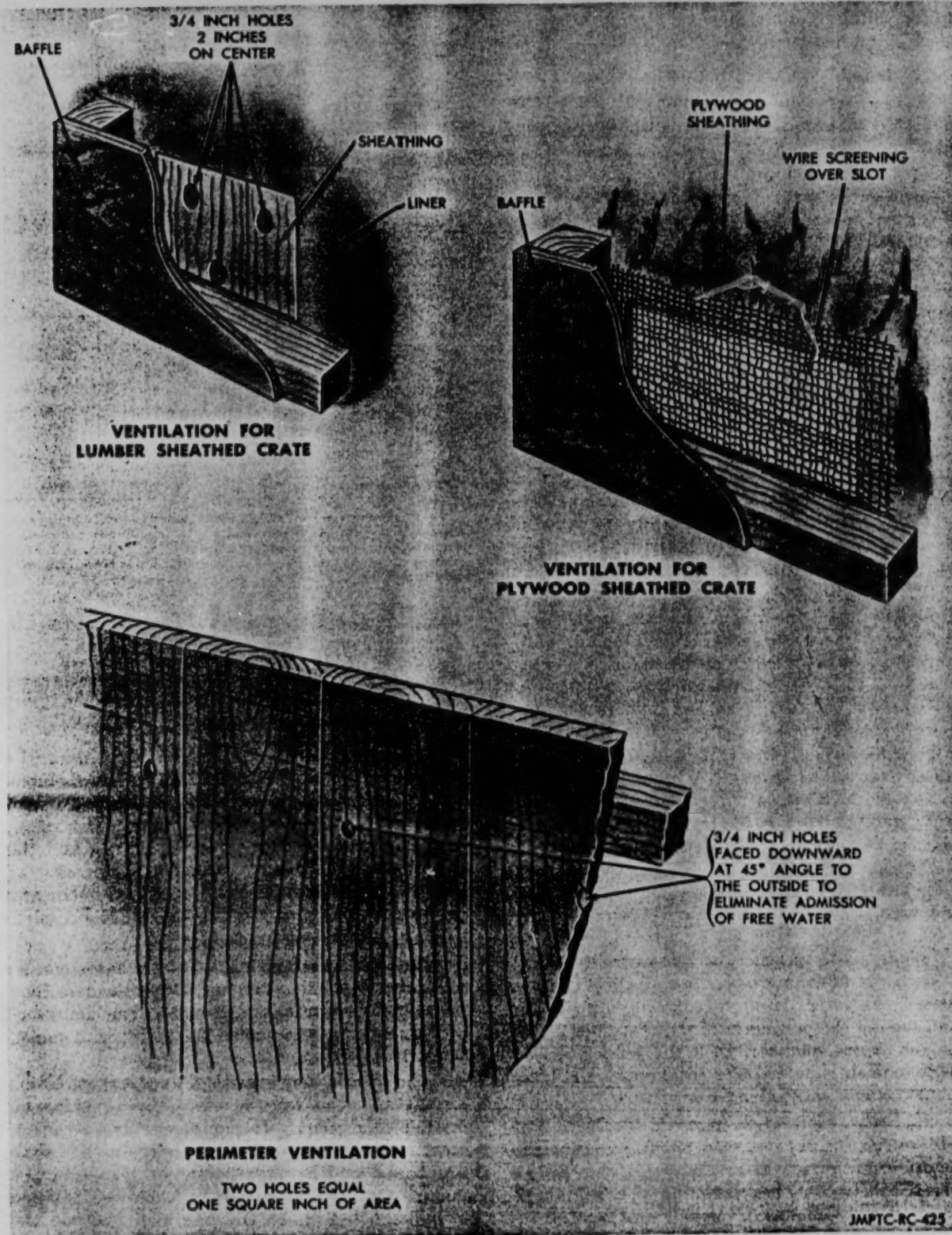


Figure 6-49. Ventilation and screening of sheathed crates.

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length, 9 feet in width, and 10 feet in height, unless different dimensions are required under special circumstances.

c. Material Requirements.

(1) *Lumber.* The requirements for lumber are as stated in paragraph 6-2a, with the following additions:

(a) At least one surface of the lumber sheathing (the surface to be placed on the outside of the crate) should be dressed to permit legible markings.

(b) Crates containing items packed within floating bags will have all load bearing members and floor members coming in contact with the barrier material dressed.

(2) *Plywood.* All plywood for sheathing will conform to Specification NN-P-530 (para 6-2b).

(3) *Inspection doors* (para 6-2l and fig 6-2l).

d. *Ventilation* (fig 6-49). All sheathed crates will be ventilated with clusters of holes located at each end, or at the ends and sides of lumber sheathed crates, or slots cut in the ends of plywood sheathed crates. Do not cut holes or slots in any frame member.

(1) *End ventilation.* Provide ventilating holes three-fourths of an inch in diameter in each end and space 2 inches on center. Place them in one or more clusters, near the upper frame members and provide with a baffle. No baffles are required for perimeter ventilation holes. In small crates, locate the holes so that the struts or diagonals can be utilized in parts as cleats for the baffle plates. In crates over 10 feet in length, divide the ventilation holes equally between the ends and sides of the crate, and provide a baffle for each group of holes. Located the cluster of holes as near the midpoint of the side and end as practical. Base the minimum number of holes for end (or end and side) and ventilation on the volume of the crate (table 6-30).

(2) *Perimeter ventilation.* Use perimeter ventilation as an alternate to end (or side) ventilation. Space $\frac{3}{4}$ inch ventilation holes evenly (in a single line) around the perimeter of the crate just below the top frame member. Drill the holes at a 45° angle to drain outward. The total number of holes should comply with table 6-30.

(3) *Slotted ventilation (plywood sheathed).* Provide ventilation for plywood sheathed crates by means of a horizontal slot at each end with a screen and baffle. The maximum size of a single slot is 4 x 12 inches. In small crates, $\frac{3}{4}$ -inch-diameter holes may be substituted for the ventilating slots in the proportion of two holes per

Table 6-30. Ventilation holes and area required (MIL-C-104)

Volume of crate (cu ft)	Lumber-sheathed crates		Plywood-sheathed crates
	End ventilation minimum number of $\frac{3}{4}$ in. diameter holes required in each end (place in clusters and use baffle)	Perimeter ventilation (alternate) total minimum number of $\frac{3}{4}$ in. diameter holes required around perimeter (space evenly and slope to drain out)	Area required in each end (use baffle and screen) (sq in.)
0-100	3	6	7
100-150	4	8	10
150-200	5	10	14
200-400	9	18	27
400-600	14	27	40
600-800	18	36	52
800-1,000	22	44	66
1,000-1,200	27	54	80
1,200 and over	33	66	100

Note 1. In long crates (over 10 feet) when specified by the procuring agency the ventilation holes may be divided equally between the ends and the sides but the total required area or number of holes shall not be less than listed.

Note 2. In large crates, when a large ventilating area is required, two or more slots or clusters of holes may be used in each panel.

square inch of required area. The required ventilating area should comply with table 6-30.

6-16. Lumber Sheathed (Class 1) Crates (MIL-C-104)

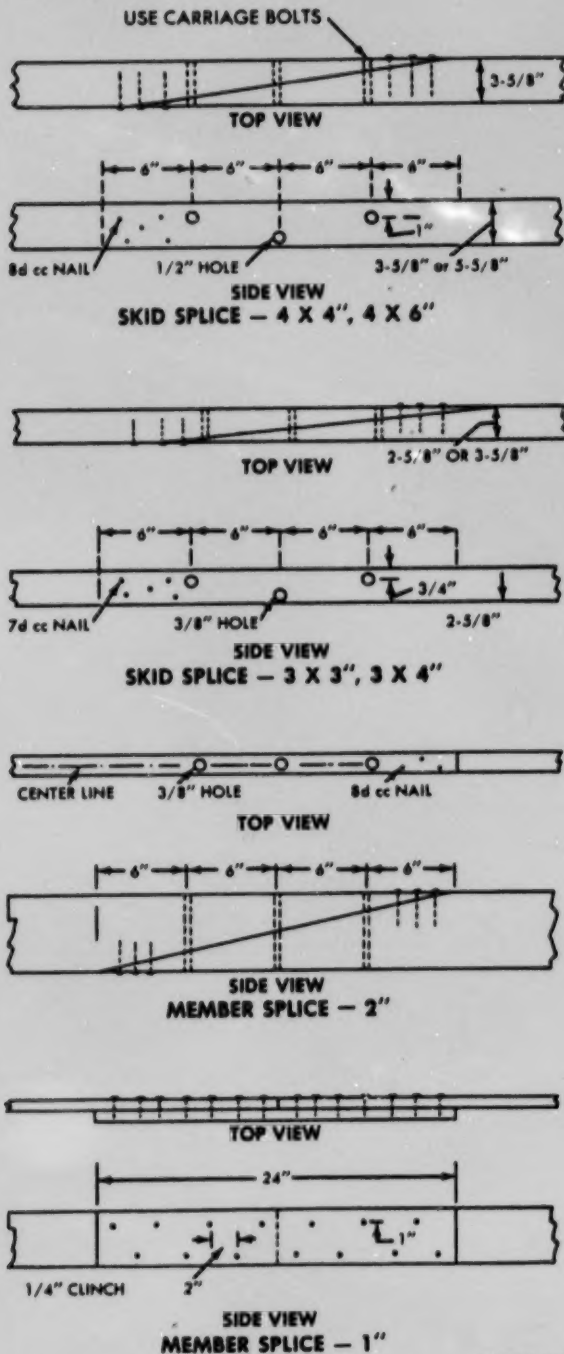
a. *Design Requirements.* Lumber sheathed crates may be either nailed or bolted for assembly. Nailed crates are fabricated and assembled with nails and straps and are not designed for reuse. Bolted crates are fabricated with nails and the panels are assembled with lag bolts for ease of disassembly or reassembly. Bases for lumber and plywood sheathed crates may be of Style A (skid) or Style B (sill) construction.

(1) *Skid bases (Style A).* Style A bases consist of longitudinal skids, rubbing strips, headers, load bearing floorboards, and flooring. The details of construction are the same for bolted and nailed crates (fig 6-11 and 6-52).

(a) *Skids.* Any species of wood, except Group I, may be used for the skids. Space skids no farther apart than 48 inches center to center, measured across the width of the crate. Skid sizes are based on the maximum net load and the maximum length of the crate (table 6-31). When either the length or the net load exceeds the limitation shown in table 6-31, use the next larger skid size.

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1. *Splicing of members.* When necessary, skids made of lumber larger than 2 x 4-inch material may be spliced and laminated according to the details shown in figures 6-50 and 6-51. When 2 x 4-inch skids are used, each should be of one piece.



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Figure 6-50. Splicing of members.

Table 6-31. Skid, Header, and Bolts Sizes (MIL-C-104)

Maximum net load (lbs.)	Maximum length of Crate (ft.)	Nominal size of skid (in.)	Nominal size of header (in.)	Bolt diameter (in.)
300	16	2 x 4 (flat) ¹	2 x 4 ²	3/8
1,000	12	2 x 4 (flat) ¹	2 x 4 ²	3/8
2,000	20	3 x 3 or 3 x 4 (flat) ³	3 x 3 or 3 x 4 (flat) ⁴	3/8
10,000	32	4 x 4	4 x 4	1/2
30,000	20	4 x 6 (on edge)	4 x 4	1/2

¹For nailed crates only.²For crates with 3-inch thick lower frame members or 2-inch end struts.³For nailed crates only in width to 48 inches. For wider crates or bolted crates, use 3 x 3 inch.⁴When 2 inches thick, end struts are required.

2. *Bolts.* To prevent skids from splitting out at the ends, place one carriage bolt crosswise and 2 to 3 inches in from each end of the skids.

(b) *Rubbing strips.* Fabricate rubbing strips for skid bases from 2-inch lumber the same width as the skid. Attach them to the skids with two rows (staggered pattern) of twelpenny coated nails spaced 12 inches apart in each row.

1. *Forklift openings.* Provide sling openings for forklift entry in the rubbing strips. These openings are 12 inches in length and 28 inches center to center. Position them to straddle the center of balance of the loaded crate. Center pieces of the rubbing strips must be at least 16 inches in length.

2. *Sling openings.* Provide sling openings not less than 4 inches in length, but preferably 8 inches, at the ends of the rubbing strips where permitted by the length of the crate and by the location of the worklift access openings. Bevel the ends of all rubbing strips at an angle of 45° at sling and forklift openings. For bases less than seven feet long, provisions for forklift openings may be omitted.

(c) *Headers.* Headers are placed at each end of the base. Header sizes are based upon skid sizes.

1. Place headers used with lumber flooring directly on the skids, back from the ends a distance equal to the thickness of the end sheathing. Notch the ends of the headers equal to the thickness of the flooring to receive the lower edge members of the sides. Bolt these members to each skid with one carriage bolt. The sizes of the headers and bolt diameters are found in table 6-31.

2. Place the headers used with plywood flooring on top of the plywood and set back from

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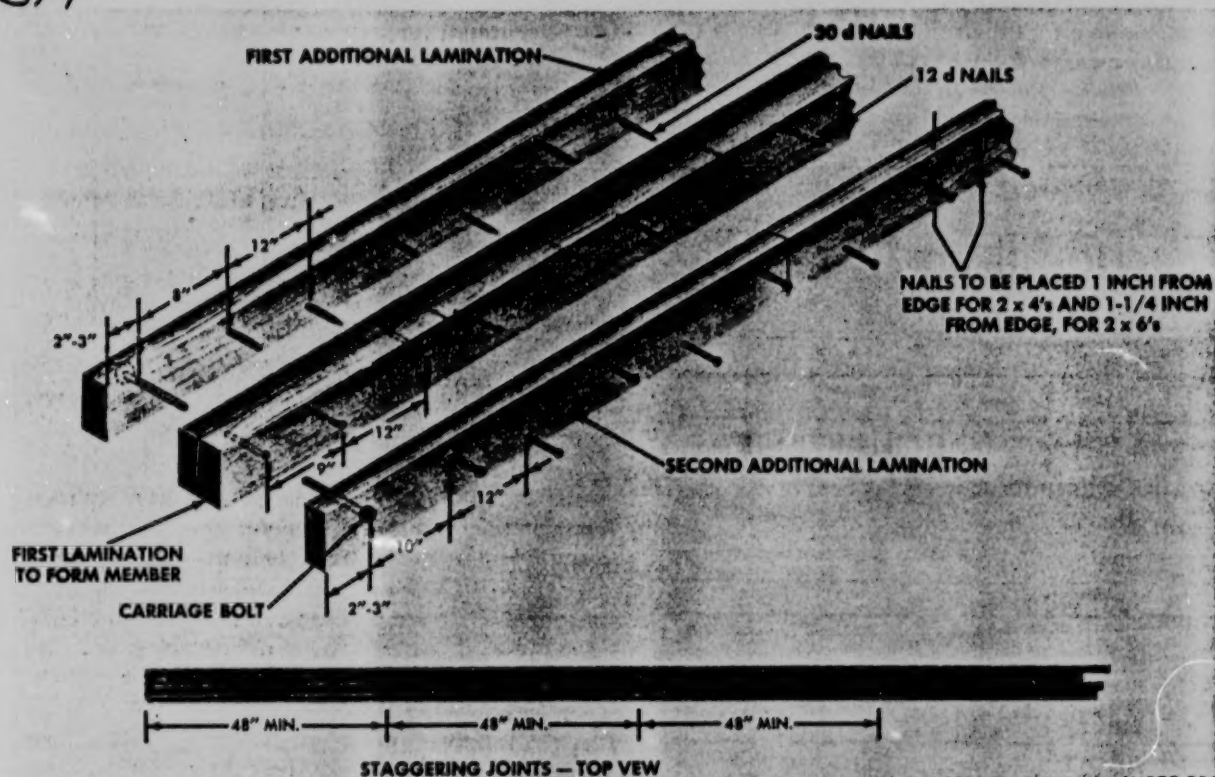


Figure 6-51. Lamination of skid or sill members.

the ends of the skids the same as required for lumber flooring. Cut off the ends of the headers a distance equal to the thickness of the lower edge members of the sides so that the lower edge members will rest on top of the plywood flooring. The size of the headers and bolt diameters are found in table 6-31.

(d) *Forklift area.* The forklift area consists of the headers and two more members of equal size, spaced 20 and 40 inches (on center) from each end of the skids and bolted to the skids.

1. When crates are short or narrow, or the above arrangement will interfere with the loading of the item, use 2-inch lumber throughout the 42-inch forklift area.

2. Space lumber flooring one-fourth of an inch apart for drainage. Nail the flooring to the outer skids and bolt to the intermediate skids when required.

(e) *Load bearing floorboards.* Load bearing floorboards are members placed across the width of the base where the concentrated load of contents occur. They also serve to distribute and transfer the load to the skids. Calculate the thicknesses of the load bearing members on the basis

of the distance between the outer skids and the concentrated load per linear inch of floorboard width. The load per inch of floorboard width is equal to the weight of the item at the heaviest concentration area in pounds, divided by the length of the concentrated area in inches. The result of this computation will give the actual load per inch in pounds. See table 6-4 for the thickness of load bearing floorboards; see figure 6-22 for use of table 6-4. When using table 6-4 if either the length between the outer skids or the weight is less than required, use the next greater length or higher poundage to determine the thickness of the load bearing floorboards.

1. The forklift members and any other 1- or 2-inch flooring may be considered as load bearing floorboards within their assigned values.

2. The length of the load bearing floorboards is the same as the headers.

3. Fasten load bearing floorboards four inches wide to each skid with one carriage bolt. Fasten load bearing floorboards over four inches wide to each skid with two bolts. The diameter of the bolts are the same as those specified for the

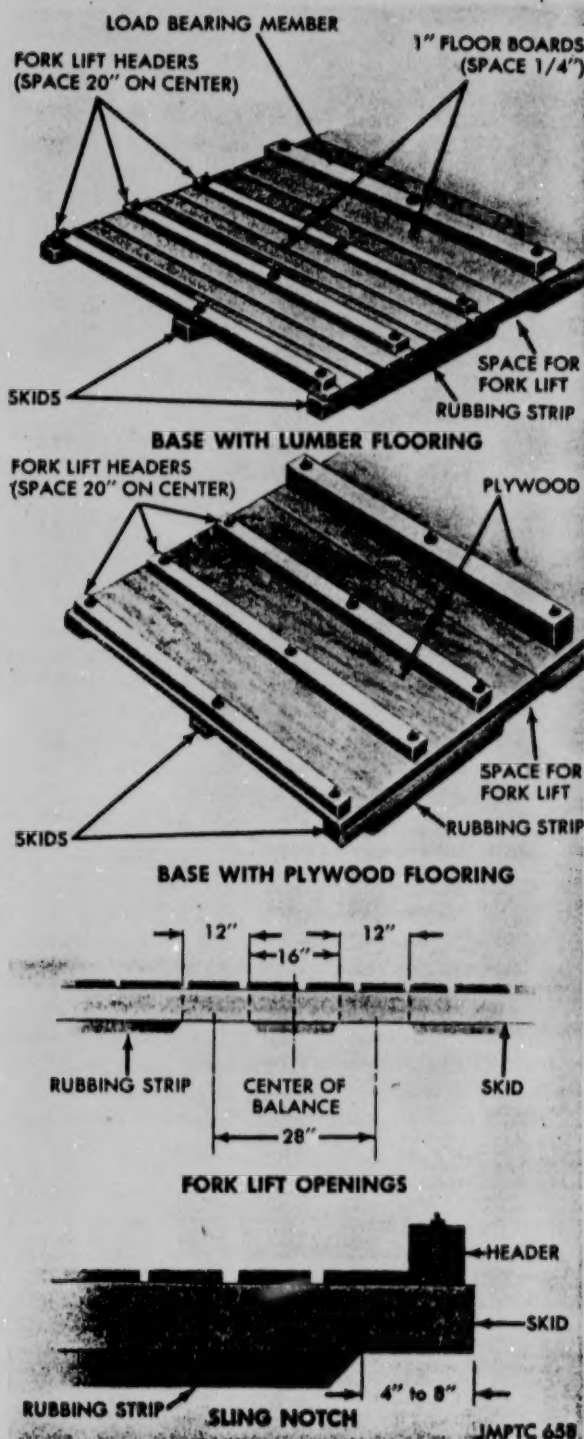


Figure 6-52. Headers, forklift openings, and sling notches on skid bases.

headers. When intermediate skids are required, the same rules apply.

(f) *Lumber flooring.* Lumber flooring must be at least 1-inch thick, not less than 4 inches in width and placed at right angles to the skids. Space the boards one-fourth of an inch apart for drainage, and place the ends flush with the outside faces of the skids. If part of the base is floored with 2-inch lumber and the rest with 1-inch lumber, use filler strips 2 inches wide along each side over the thinner flooring to equal the thickness of the 2-inch flooring (fig 6-53). Nail filler strips with two rows (staggered pattern) of sixpenny nails spaced 10 inches apart.

(g) *Plywood flooring.* Plywood of Group I or II woods, three-eighths of an inch in thickness, may be used in lieu of 1-inch lumber flooring, but not as load bearing floorboards. Lay plywood flooring flush with the outer edges of the skids with the face grain perpendicular to the skid length. Space each piece of plywood one-fourth of an inch apart for drainage and nail to each skid with two rows (staggered pattern) of sevenpenny nails, spaced 6 inches apart in each row. When one-third to one-half the area of the base is floored with 2-inch lumber, use plywood flooring between those areas and nail 2-inch filler strips over the plywood (fig 6-53). Drill a drainage hole one-half of an inch in diameter adjacent to each header or load bearing member. Locate the holes on the outer edge of each plywood floored section (a "section" being an unjoined portion of plywood located between two members) of the base where water might be trapped. Locate the holes so that they will not be covered when the contents are placed on the base of the crate.

(2) *Sill bases (style b).* Style b bases consist of side, end, and intermediate sills, load bearing headers, bridging, bottom sheathing, and rubbing strips. These bases are designed for the weight of contents to be transmitted to the side sills through the intermediate sills or by the item itself. Details of construction are the same for nailed and bolted assembly (fig 6-10).

(a) *Side and end sills.* The size of the side sills is based on the gross weight of crate and contents and length of the crate. The end sills are the same dimensions as the side sills (table 6-32). The side sills should overlap the end sills. When necessary, the sills may be spliced and laminated (fig 6-50 and 6-51).

(b) *Intermediate sills.* Apply intermediate sills crosswise to the length of the base and parallel to the end sills. Attach the intermediate sills at their ends to the side sills with a combina-

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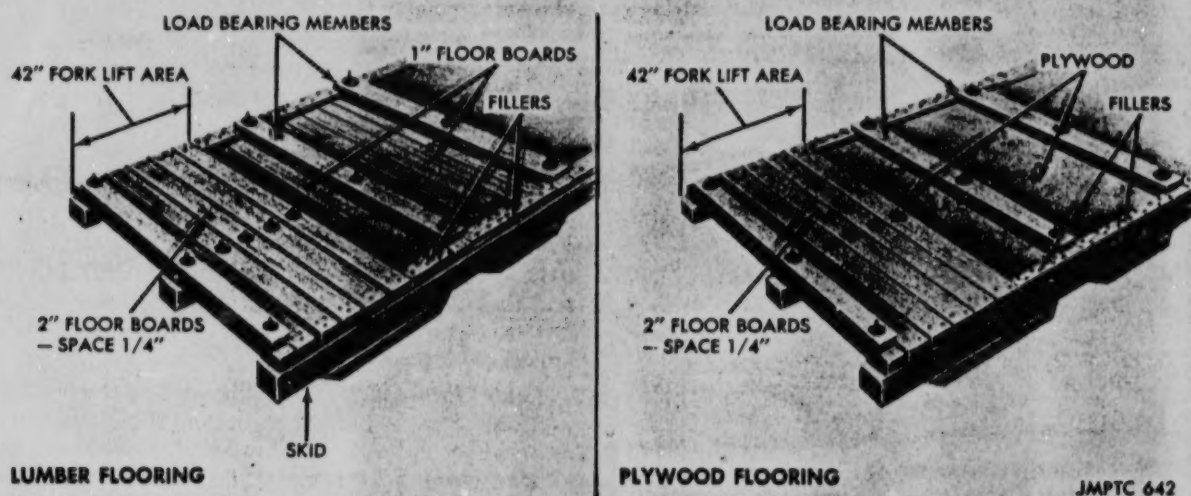


Figure 6-53. Skid base—partial 2-inch flooring.

tion of nails and meter strap hangers. Fabricate hangers from $1\frac{1}{2} \times 0.035$ -inch nail-on strapping (fig 6-17). Determine the size of the intermediate sill by using the length of the sill and the amount of weight actually supported by that sill (table 6-33).

(c) *Load bearing members.* Load bearing headers are pieces of lumber placed between a set of intermediate sills, when necessary, to support the contents. Load bearing headers are the same size as the intermediate sills. These members are not required when all the load is supported by the side sills. Attach the load bearing headers at their ends to the intermediate sills in the same manner as described in (b) above.

(d) *Bridging.* Use 1-inch lumber to bridge intermediate sills at the ends. The nail size depends upon the thickness of the side sills. Use 2-inch lumber the same depth as the intermediate sills at intervals not to exceed 4 feet. This material

will add strength and rigidity to the base structure (fig 6-10).

(e) *Bottom sheathing.* Style B bases are sheathed with lumber laid at right angles to the side sills and secured with nails. Use boards from 4 to 10 inches wide and not less than 1 inch thick for spans of less than 30 inches between side sills. Use boards 2 inches thick for spans of 30 inches or more. Lay the bottom sheathing flush with the outside edges of the sills and space one-fourth of an inch apart for drainage. Secure 1-inch sheathing boards with eightpenny nails and 2-inch boards with twelpenny nails in accordance with the nailing pattern (fig 6-54).

(f) *Rubbing strips.* Fabricate the rubbing strips from 2-inch lumber at least 4 inches wide. Place these members lengthwise beneath the bottom sheathing under each side sill. Locate intermediate rubbing strips of the same size between the outer rubbing strips so that the clear distance

Table 6-32. Nominal Sizes of Side Sills (MIL-C-104)

Gross weight of crate lb	Length of crate (ft)							
	4	8	12	16	20	24	28	32
To 2,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 4	2 x 6	2 x 6	2 x 6
2,000-4,000	2 x 4	2 x 4	2 x 4	2 x 4	2 x 6	2 x 6	2 x 6	2 x 8
4,001-6,000	2 x 4	2 x 4	2 x 4	2 x 6	2 x 6	2 x 6	2 x 8	2 x 8
6,001-8,000		2 x 4	2 x 6	2 x 6	2 x 6	2 x 8	2 x 8	2 x 8
8,001-10,000		2 x 6	2 x 6	2 x 6	2 x 8	2 x 8	2 x 8	2 x 10
10,001-12,000		2 x 6	2 x 6	2 x 8	2 x 8	2 x 8	2 x 10	2 x 10
12,001-14,000		2 x 6	2 x 8	2 x 8	2 x 8	2 x 10	2 x 10	2 x 10
14,001-16,000		2 x 8	2 x 8	2 x 8	2 x 10	2 x 10	2 x 10	2-2 x 8
16,001-18,000		2 x 8	2 x 8	2 x 10	2 x 10	2 x 10	2-2 x 8	2-2 x 8
18,001-20,000		2 x 8	2 x 10	2 x 10	2 x 10	2-2 x 8	2-2 x 8	2-2 x 8

Note. The above sizes are for crates with a height of over 3 feet. For heights of three feet or under, increase 2 x 4 sizes to 2 x 6; increase 2 x 6 sizes to 2 x 8; increase 2 x 8 sizes to 2 x 10; and increase two 2 x 8 sizes to two 2 x 10.

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Table 6-33. Allowable Load for Intermediate Sills in Pounds Per Inch of Sill Width

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Length of sill (ft.)	Sill depth—Actual sizes						
	Groups I and II woods						
	1-5/8 in.	2-5/8 in.	3-5/8 in.	5-5/8 in.	7-1/2 in.	9-1/2 in.	11-1/2 in.
	Pounds						
4	55	144	274	659	1,172	1,880	2,775
5	44	115	219	527	937	1,504	2,204
6	37	96	183	440	781	1,254	1,837
7	31	82	157	377	670	1,074	1,574
8	28	72	137	330	586	940	1,378
9	24	64	122	293	521	835	1,224
10	22	57	110	264	469	752	1,102

Note. If Group III or IV woods are used, the above allowable loads may be increased by 20 percent.

between strips does not exceed 36 inches. Normally, these members are placed underneath a sill, providing they are within the 36-inch span requirement. The requirements for fork-lift openings, sling points, and nailing of rubbing strips, are the same as specified for Style A, skid base.

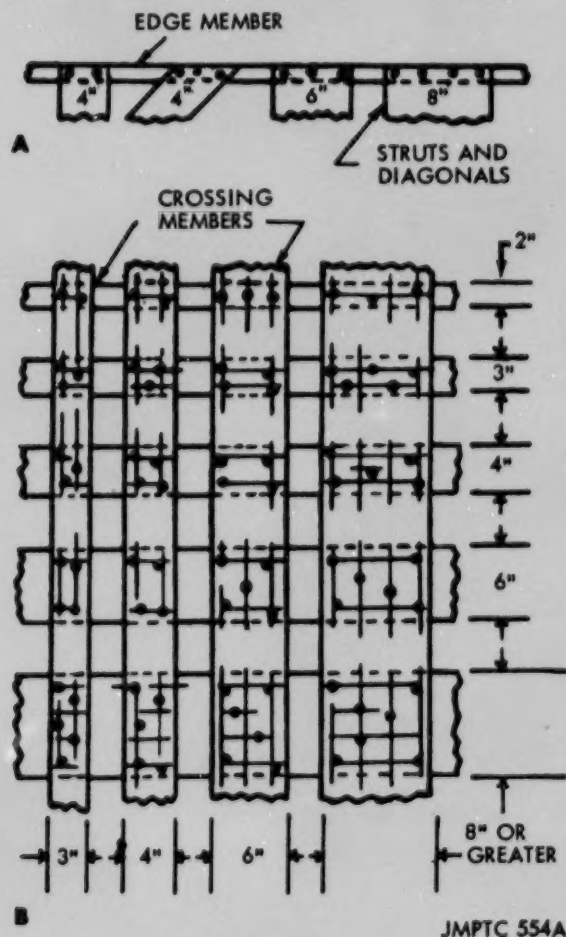


Figure 6-54. Nailing patterns.

(3) *Sides.* The sides for class 1 (lumber sheathed) crates consist of the upper and lower frame members, vertical struts, diagonals, joist supports, horizontal braces, liners, gusset plates, and lag bolts reinforcing straps when the crates are bolted (fig 6-55).

(a) *Type and number of panels.*

1. The types of side panels (A, B, or C) are based on the inside height of the crate (table 6-34).

Table 6-34. Types of Panels for Lumber Sheathed Crate (MIL-C-104)

Inside height of crate	Type of panel	Framing pattern
Over 24-60 inches	A	fig 6-55
Over 60-108 inches	B	fig 6-55
Over 108-144 inches	C	fig 6-55

2. The number of panels for each side is computed by dividing the inside crate length by the inside crate height, and using the nearest whole number.

Examples: A crate that is 12 feet long and 9 feet high requires only one type B panel for a full length side. A crate that is 14 feet long and 5 feet high would require three type A panels for a full length side.

(b) *Selection of members.* Determine the sizes of the upper and lower frame members, struts, and diagonals from tables 6-43 through 6-52. Loads referred to in the tables are based on the net weight of contents and the inside dimensions of the crate. Member sizes are based on group II woods. When using the tables, if the exact size of the crate is not given in the tables, use the member sizes given for the crate of the next longer length, the next greater width, and the next smaller height.

(c) *Upper and lower frame members.* Upper frame members for crates over 54 inches wide

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require 2-inch members. The members must be a minimum of 2 x 4-inch size, except when vertical joist supports are required. These members may be spliced, providing they are spliced over or under a strut. Splicing of the members must be in accordance with the details shown in figure 6-50. Determine the sizes of the upper and lower frame members from tables 6-43 through 6-52.

(d) *Vertical struts.* Vertical struts must be a single continuous piece from the lower to the upper frame member. Base the size of the end vertical struts on the net load and the type of crate (nailed or bolted) (table 6-35). Determine the intermediate strut sizes from tables 6-43 through 6-52.

Table 6-35. Nominal Size of End Struts for Sides
(MIL-C-104)

Net load (lb)	Nailed crate (in.)	Bolted crate (in.)
1,000 or under	2 x 4	2 x 4
Over 1,000 but under 5,000	2 x 4	3 x 3
Over 5,000	2 x 4	4 x 4

(e) *Diagonals.* The size of diagonals are found in tables 6-43 through 6-52. When frame members are 1-inch lumber and the height is over 36 inches, use gusset plates fabricated from plywood one-fourth of an inch thick, and at least 12 inches in the shortest dimension, at the intersection of the diagonals. The corners of the gusset plates should coincide with the center line of the diagonals (fig 6-56). Secure gusset plates with a minimum of three sevenpenny nails in each member. Clinch nails on the sheathing side.

(f) *Horizontal braces.* Use horizontal braces only in the construction of Type B and C panels. They are the same thickness as the struts and are 4 inches wide.

(g) *Joists supports.* Use these members in conjunction with the upper frame members of the sides to support the top. When crates are 6 feet wide and 12 feet high, or 8 feet wide and 10 feet high, with struts 1 inch thick, 2 x 4-inch supports are required. Place the supports over the framing under each joist of the top, extending down to the base. Secure them with two tenpenny nails at each horizontal frame member and one tenpenny nail at each diagonal frame member. When securing joist supports, use ninepenny nails on plywood sheathing and tenpenny on lumber sheathing.

(h) *Liners* (para 6-2i and fig 6-10).

(i) *Sheathing.* Apply the sheathing boards always vertically on the sides and ends on both skid and sill base crates. Extend the boards to the

bottom of the skids on skid bases and to the bottom of the sills on sill bases.

1. The sheathing boards may be either tongue-and-groove, square, or Linderman-jointed. Two or more pieces that are Linderman-jointed are considered as one piece (para 3-2e(2) and fig 3-11).

2. Boards five-eighths of an inch thick may be used for sheathing for net loads less than 300 pounds, and nominal 1-inch for net loads over 300 pounds.

3. Boards must not be less than 4 inches wide and only 10 percent of the boards used (not more than one out of 10 boards) may be of the minimum width.

4. Boards used at the corners must be full length and at least 6 inches wide. At least every second board must be full length also.

5. Short boards, not less than 2 feet long, may be used. Cut the boards at right angles and locate the center of the short boards at the approximate center of the width of a diagonal. Have complete coverage of the diagonal, or join in the center of a horizontal member (fig 6-57). Butt joints are not permitted to be adjacent to each other.

(j) *Nailing lumber sheathing.* Drive the nails all the way through the sheathing and into the framing members and clinch a minimum of one-fourth of an inch (fig 6-57).

1. *Horizontal and diagonals.* Use three rows of nails, three nails minimum per board crossing, to secure the sheathing to horizontals and diagonals 4 to 6 inches wide. Use a minimum of four nails in wider boards. Use four rows of nails, four nails minimum per board crossing, to secure sheathing to horizontals and diagonals 4 to 8 inches wide. Use a minimum of five nails in wider boards.

2. *Struts.* Use two rows of nails for nailing the sheathing to struts 4 to 6 inches wide. Space the nails approximately 8 inches apart in each row in a staggered pattern. Use three rows of nails for nailing the sheathing to struts over 6 inches wide. Space the nails approximately 12 inches apart in each row in a staggered pattern.

3. *Gusset plates.* Use sevenpenny nails driven from the gusset plates and clinch on the sheathing.

4. *Vertical joist supports.* Secure the vertical joist supports with tenpenny nails. Use two at each horizontal frame member crossing, one at each diagonal crossing, and two rows of nails, 30 inches on center, where the vertical joists coincide with the struts.

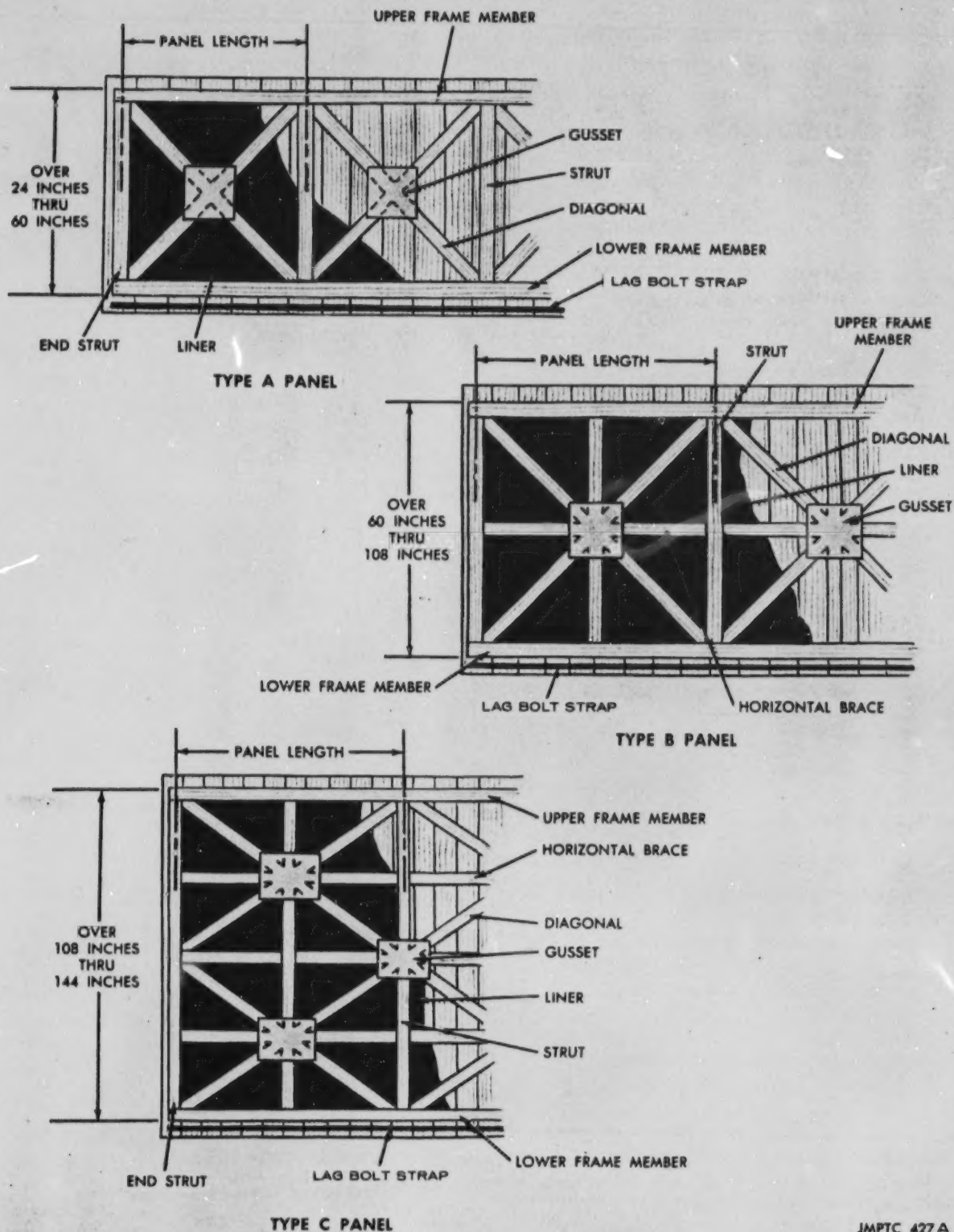


Figure 6-55. Types and number of lumber panels.

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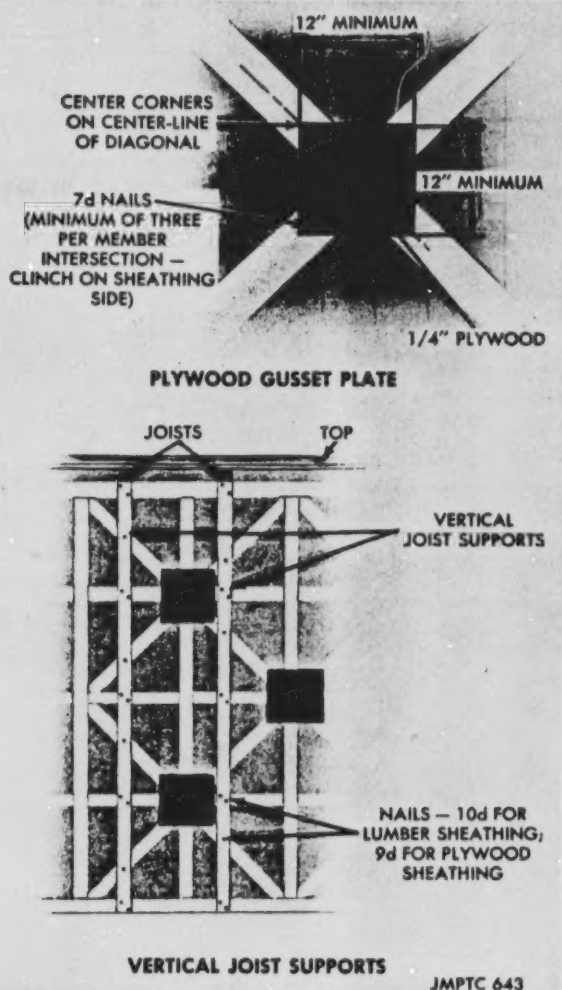


Figure 6-56. Joint supports and gusset plates.

(k) *Lag bolt reinforcing straps.* Use lag bolt reinforcing straps on all bolted crates as illustrated in figure 6-16. These straps run the full length of each panel on all bolted crates.

1. Nail galvanized steel straps, punched or drilled ($1\frac{1}{4}$ x 0.035-in. strap for $\frac{3}{8}$ -in. lag bolts and 2 x 0.050-in. strap for $\frac{1}{2}$ and $\frac{5}{8}$ -in. lag bolts) to the inner face of the sheathing, between the lower edge of the lower frame member and the bottom of the sheathing.

2. Locate the straps to coincide with the center of the skids on the sides and center of the headers on the end. Secure the straps to the sheathing with clout or similar nails and space a maximum of two inches on centers. Clinch the nails at least three-eighths of an inch on the sheathing side.

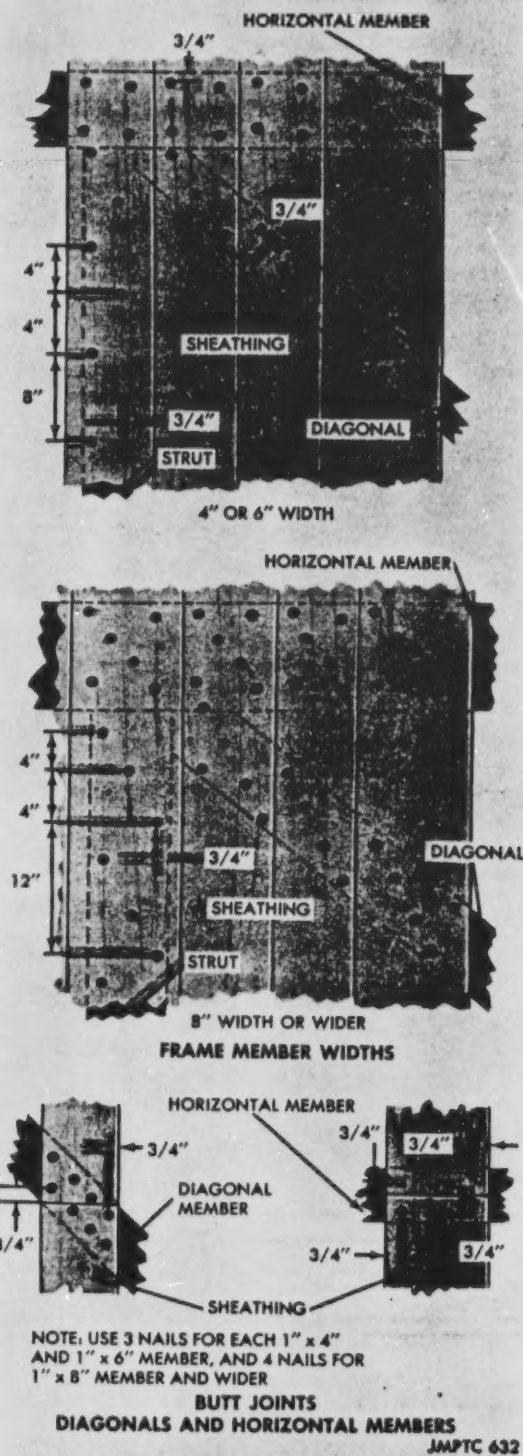


Figure 6-57. Fabrication nailing.

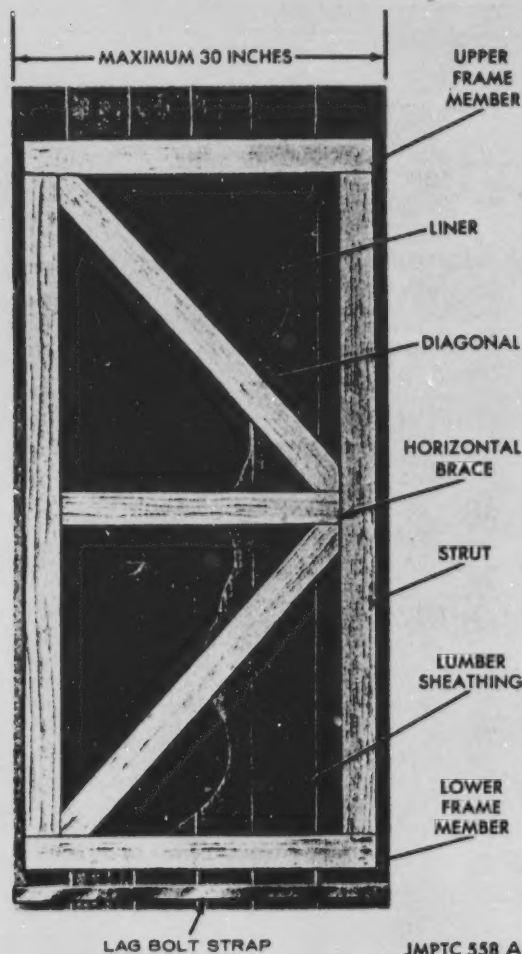


Figure 6-58. Narrow end panel.

(4) *Ends (lumber sheathed).* The types of end panels and the size of the framing members for crates over 30 inches wide are determined in the same manner as for the sides. The thickness of the upper and lower edge frame members are always the same as for the struts (tables 6-43 and 6-52 and fig. 6-55). When the crate is less than 30 inches wide, use single diagonals and 1 x 4-inch framing (fig 6-58). The requirements for sheathing, liners, nailing, and the use of lag bolt reinforcing straps for bolted crates are the same as for the sides.

(5) *Tops (lumber and plywood sheathed).* The tops for both lumber and plywood sheathed crates are constructed in the same manner. They consist of framing members and three additional layers of material; a plywood underlayer, roofing felt, and an upper layer of lumber sheathing (fig 6-59). The

plywood must be weather-resistant and one-fourth of an inch thick. Place the face grain of the plywood parallel to the width of the top, and flush with the outside of the framing members. Make the joints in the plywood over a joist or other frame members. Apply roofing felt on the top of the plywood and extend to the outside edges of the framing members a distance equal to the thickness of the side and end sheathing, minus one-eighth of an inch. Overlaps in roofing felt must be at least 4 inches and sealed with asphalt mastic compound. Lap the top sheathing boards over the top framing members a distance equal to the thickness of the sheathing minus one-eighth of an inch. Tops for these crates are classified according to the width of the crate (inside measurement from sheathing to sheathing) (table 6-3b).

(a) *Narrow tops.* Frame narrow tops on 2 x 4-inch framing members placed flat. When joints are required in the plywood, use a 2 x 3-inch member on the frame side of the top. Apply top sheathing boards across the width of the crate. When required, place grabhook reinforcing joist to coincide with the center of balance of the loaded crate. Determine the size of the reinforcing joist from table 6-38.

(b) *Intermediate tops.* Frame intermediate tops on 2 x 4-inch end joists (flat) and 2 x 6-inch intermediate joist (flat). Hold them in place at their ends with 3/4 x 2-inch headers. Space intermediate joists as follows: 24 inches from the outer edge of one end joist to the center of the first intermediate joist, and 24 inches (maximum) from center to center on additional intermediate joists.

1. Apply top sheathing parallel to the length of the top.

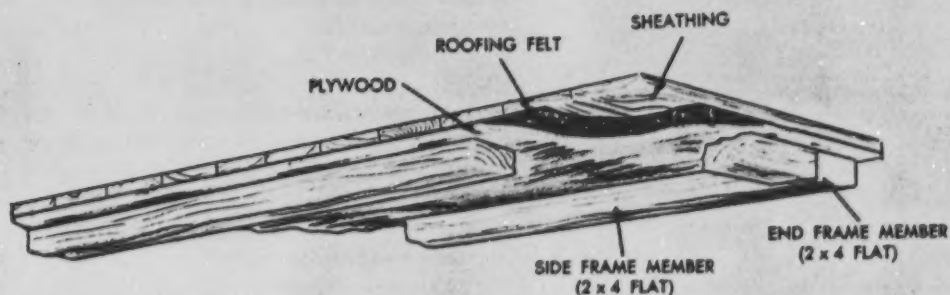
2. For crates over 10 feet long, the sheathing boards may be butt joined over the joists. Joints are not permitted to be adjacent to each other, and not more than one-third of the joints should be made over any one joist.

3. When an intermediate joist does not coincide with the center of balance, select the appropriate size from table 6-38 and place the joist at the center of balance.

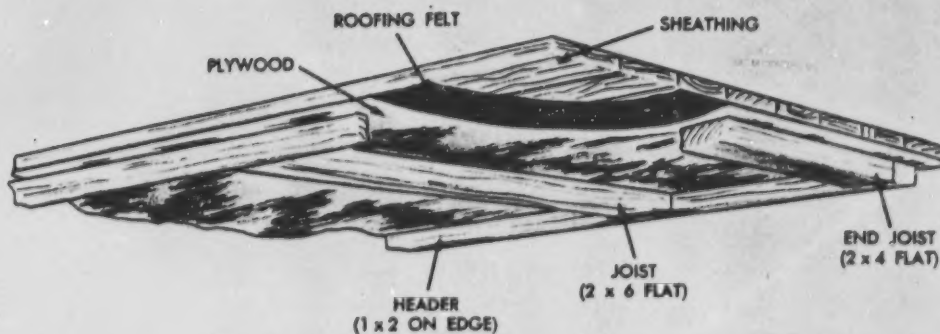
(c) *Wide tops.* Wide tops are constructed similar to intermediate tops, except the size of joist will vary depending upon the width of the crate. Place all joists on edge and space them not more than 24 inches on center (see table 6-37). Figure 6-59 shows the size of joists for spans of 90 through 120 inches.

1. When joists are given as nominal 2-inch and a nominal 1-inch piece combined, a nominal 3-

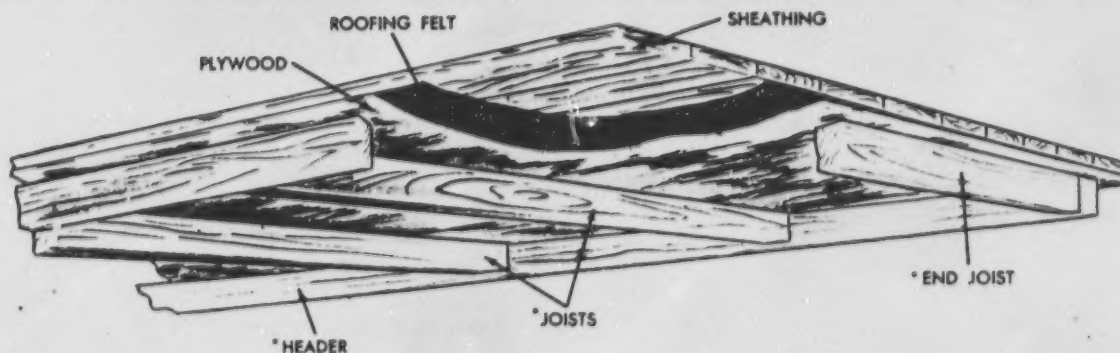
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NARROW CRATE TOP
WIDTH UP THRU 54 INCHES



INTERMEDIATE CRATE TOP
WIDTH OVER 54 INCHES THRU 60 INCHES



*SIZE DEPENDS UPON CRATE WIDTH

WIDE CRATE TOP
WIDTH OVER 60 INCHES THRU 120 INCHES

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Figure 6-59. Top construction (MIL-C-104).

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Table 6-36. Classification of Tops (MIL-C-104)

Width of top (in.)	Kind of top
Up to 54	Narrow
Over 54 through 60	Intermediate
Over 60 through 120	Wide

inch or actual $2\frac{3}{8}$ -inch of the same depth may be used.

2. A nominal 4-inch piece, or actual $3\frac{1}{4}$ -inch, may be substituted for two 2-inch pieces of the same depth.

3. If joists are not used, or when a joist does not coincide with the center of balance, place a reinforcing joist at the center of balance to distribute the load when the crate is lifted with a single set of grabhooks (table 6-38). When the gross load exceeds 22,000 pounds, or the width exceeds 96 inches for any load over 10,000 pounds, place two 4 x 4-inch joists 2 to 3 feet each way from the center of balance. This arrangement will provide for the use of two sets of grabhooks.

4. When two members 1 and 2 inches thick are nailed together for joists, use seven-penny nails, with the heads in the thinner piece. If two members are 2 inches thick, use twelve-penny nails to secure the members. Stagger the nails in two rows at least 1 inch from the edges and 18 inches apart in each row.

b. Fabrication of Lumber Sheathed (Class 1) Crates.

Table 6-37. Size of Joists for Wide Tops (MIL-C-104)

Span	Nominal size (in.)
Over 60 through 66	2 x 4
66 through 78	2 x 4 plus 1 x 4 or 13 x 4
78 through 90	2-2 x 4's or 14 x 4
90 through 102	2 x 6
102 through 120	2 x 6 plus 1 x 6 or 13 x 6

Note. All headers are $\frac{3}{4}$ of an inch thick and the same depth as the joists.
 1 End joists are single 2-inch members and the same depth as the joists.

Table 6-38. Grabhook Reinforcing Joist (MIL-C-104)

Size of reinforcing joist (in.)	Gross loads not exceeding (lbs)	Length of joist not exceeding (in.)
2 x 4	1,000	72
2 x 4	2,000	60
2 x 4	3,000	48
2 x 4	5,000	36
4 x 4	10,000	96
4 x 4	15,000	72
4 x 4	22,000	60

(1) Skid bases (fig 6-11, 6-52, and 6-53).

(a) Headers to the skids.

1. Place the headers on the skids and set back on the skids a distance equal to the thickness of the sheathing.

2. The clear distance between the skids (center to center) is not more than 48 inches.

3. Determine the bolt size from the size of the skid and the header size.

4. Drill the bolt holes through the headers and skids the same diameter as the bolt shank.

5. Install the carriage bolts, apply the washers and nuts, and tighten the nuts, forcing the square necks of the bolts into the wood.

6. Apply P-1 or P-19 preservative or paint to the threads above the nuts to prevent loosening.

7. Cut the headers to extend between the lower edge members if plywood flooring is used.

8. Install the correct size of carriage bolts crosswise to the grain of the skids, 2 to 3 inches from each end of each skid to prevent splitting.

(b) Load bearing floorboards to the skids.

1. Place the load bearing floorboards at right angles to the skids.

2. Select the correct size and number of bolts and drill the required holes through the floorboards and skids (table 6-31).

3. Install the carriage bolts, apply washers and nuts, and tighten the nuts to force the square necks of the bolts into the wood.

4. Apply paint or P-1 or P-19 preservative to the threads to prevent the nuts from loosening.

(c) Forklift members to the skids.

1. Use two members of equal size, preferably the size of the header or larger.

2. Place the members at right angles to the skids and space them 20 inches and 40 inches (on center) from the ends of the skids.

3. Select the correct size carriage bolt and drill the holes the same diameter as the shank in each member and skid.

4. Bolt the members to the outer skids, and to the intermediate skids, if they are used.

(d) Forklift floorboards to the skids.

1. Use 2-inch boards to cover the 42-inch area between the skids when the shape of the item makes the use of forklift members impractical.

2. Space the boards one-fourth inch apart for drainage and nail them to the outer skids with twelpenny coated nails (fig 6-54).

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3. Bolt the floorboards to the intermediate skids with one carriage bolt, using the same size bolt as for the header.

(e) *Load bearing floorboards to the skids.*

1. Place the load bearing floorboards at right angles to the skids at points where the load will rest.

2. Notch the floorboards or set them back from the edge of the skids (as required for the headers).

3. Use the same size of bolts as used for the headers. Locate and drill the holes through the floorboards and skids.

4. Use one carriage bolt on each end of headers 4 inches wide. For those over 4 inches wide, use two bolts in each end.

5. Install the bolts, washers, and nuts, and tighten.

(f) *Nonload bearing floorboards to the skids.*

1. Use boards no less than 1 inch thick and not less than 4 inches wide.

2. Position the boards at right angles to the skids and space them one-fourth of an inch apart for drainage.

3. With the ends flush with the outside faces of skids, nail them together using coated nails long enough to penetrate $1\frac{1}{2}$ inches into the skids.

4. Determine the number of nails for securing the floorboards to the skids by adding the width of the two pieces together and dividing the sum by two. Subtract one from the result and this will give the number of nails to use. For example, nailing a board 6 inches wide to a skid 4 inches wide would be: $6 + 4 = 10 \div 2 = 5 - 1 = 4$. Four nails would be used on each end of the board.

5. Use filler strips 2 inches wide and place over the ends of the floorboards (parallel to the skids) to level the floor. Secure the filler strips with two rows of sixpenny nails in a staggered pattern and space 10 inches apart in each row.

(g) *Plywood flooring to the skids.*

1. Position the plywood flooring with the face grain at right angles to the length of the skids and the edges flush with the outer edges of the skids.

2. Secure the plywood with two rows of sevenpenny nails staggered 6 inches apart.

3. Use filler strips, when required, and nail the same as lumber flooring.

4. Drill $\frac{1}{2}$ -inch holes in the corners of the plywood floored section next to the headers and the forklift members to permit drainage.

5. Place the headers, forklift members, and load bearing members of top of the plywood flooring and bolt to the skids.

(h) *Rubbing strips to the skids.*

1. Remove the base from the jig and turn skid side up.

2. Cut pieces of 2-inch lumber, the same width as the skids, 8 to 16 inches shorter than the skids, to provide sling notches 4 to 8 inches long at each end of the skids.

3. Forklift openings (when used) are 12 inches long and spaced 28 inches center to center.

4. Position the pieces so the openings straddle the center of balance of the crate with the center pieces no less than 16 inches long. Bevel the ends of all pieces at a 45 degree angle.

5. Nail the pieces to the skids with two rows of twelpenny nails spaces 12 inches apart in each row. Use a staggered pattern.

(2) *Sill bases (fig 6-10).*

(a) *Side sills to the end sills.*

1. Place the side sills to overlap the end sills.

2. Nail the side sills to the end sills using three coated nails in each end. The nails must be of sufficient length to penetrate the end grain of the end sill a depth equal to twice the thickness of the side sill.

(b) *Intermediate sills to the side sills.*

1. Place the intermediate sill in the jig at right angles to, and between the side sills.

2. Install the preformed metal strap hanger (para 6-16a(2)(b) and fig 6-17).

3. Drive three coated nails through the metal hanger, through the side sill, and into the end grain of the intermediate sill.

4. Nail the metal hanger to the underside of the intermediate sill with four eightpenny coated nails, and to the upper edge of the side with one eightpenny coated nail.

(c) *Load bearing headers.*

1. Cut the load bearing headers from lumber of the same width as the intermediate sill.

2. Position the load bearing headers at right angles to the intermediate sills and parallel to the side sills.

3. Install the metal hangers on the ends of the load bearing headers, over the intermediate sills.

4. Drive three twentypenny coated nails through the metal hanger, through the intermediate sill, and into the end grain of the load bearing header.

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5. Nail the metal hanger to the underside of the load bearing header with four eightpenny coated nails, and to the upper edges of the intermediate sills with one eightpenny coated nail.

(d) *Bridging.*

1. Cut 1-inch pieces, the same width or depth as the side sills, to fit between the intermediate sills and the end sills.

2. Position the pieces at the ends of the intermediate sills against the inner faces of the side sill and nail to the side sills with two rows of eightpenny coated nails spaced 12 inches apart in a staggered pattern.

3. Cut 2-inch pieces, the same width or depth as the side sills, to fit between the intermediate sills and the end sills.

4. Position the pieces on edge, every 4 feet along the length of the intermediate sill.

5. Nail through the intermediate sill into the end grain of the bridging using a minimum of three twelpenny coated nails at each end.

(e) *Bottom sheathing.*

1. Remove the sill frame from the jig and turn bottom side up.

2. Position the bottom sheathing at right angles to the length of the side sills, with the ends flush with the outside edge of the sills and spaced one-fourth of an inch apart for drainage.

3. Nail the bottom sheathing to the sills and bridging (para 6-16a(2)(e) and fig 6-54).

(f) *Rubbing strips.*

1. Cut the rubbing strips from 2-inch lumber not less than 4 inches wide and 8 to 16 inches shorter than the crates. Bevel the ends at a 45° angle.

2. Position the rubbing strips lengthwise to the crate, under each lengthwise member.

3. Adjust the location of the pieces to provide 4- to 8-inch notches at each end of the crate.

4. Use an intermediate rubbing strip when the clear distance between strips exceeds 36 inches.

5. Nail the rubbing strips to the bottom sheathing and the frame members with two rows of twelpenny coated nails, spaced 12 inches apart in each row.

(3) *Side panels.*

(a) Position the precut frame members in a temporary jig in the proper relationship to each other and unroll Specification PPP-B-1055 barrier material. Type E-2, C-2, or L-2, horizontally over the frame members (para 6-2i).

(b) Arrange the sheathing boards in place over the frame members with the dressed side of the board on the outside (fig 6-57).

(c) Use a chalk line to snap a centerline on the top of sheathing over each frame member. If preferred, snap a line on top of the sheathing over the two edges of each frame member.

(d) Use nails long enough to penetrate the sheathing and framing and clinch one-fourth inch. Bright (uncoated) nails may be used (para 6-16a(3)(j) and fig 6-57).

(e) Attach the vertical joist supports to the frame members (when required).

1. Remove the panel from the jig and turn the panel over.

2. Cut the pieces to the proper size to extend from the upper edge of the upper frame member to the lower edge of the lower frame member.

3. Locate these pieces along the upper and lower frame members, at right angles to the upper frame member at points where the top joist will bear.

4. Nail the joist supports to each horizontal member with two tenpenny nails and clinch. Nail to each diagonal with one clinched tenpenny nail.

5. When joist supports coincide with the struts, use two rows of tenpenny nails spaced 30 inches apart.

(f) Attach the lag bolt reinforcing strap (when required).

1. Locate the strap on the side sheathing near the lower edge panel, at the center line of the skids (para 6-16a(3)(k) and fig 6-16).

2. Nail the strap to the sheathing with clout nails, spaces 2 inches apart, and clinch a minimum of three-eighths inch on the outside of the sheathing.

(g) Attach the gusset plates (when required) (fig 6-56). Nail through the gusset plate, frame members, and sheathing, with sevenpenny nails and clinch. Use at least three nails in each member.

(h) Install crate ventilation (table 6-30, para 6-15d(1) and (2) and fig 6-49).

1. *Cluster of holes and baffle.* Locate the area for the holes and drill a cluster of 3/4-inch diameter holes on 2-inch centers. Clean the chips and barrier material away from the hole, then cut a baffle from a piece of 1/4-inch plywood or metal, large enough to cover the holes. Nail a 2 x 2-inch batten below and on the sides of the holes, using

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Table 6-39. Assembly Nailing of Nailed Crate (MIL-C-104)¹

Fasten		Nail size and spacing		Notes
Part	To part	Lumber sheathing	Plywood sheathing	
Sheathing of side and end.	Skid and end header (skid base).	Eightpenny minimum size 3-inch maximum spacing.	Sevenpenny minimum size 3-inch maximum spacing.	See table 6-40 for number of nails required.
	End and side sills (sill base).	Two rows up to 4 x 4 skids Three rows for 4 x 6 skid (on edge). Three rows for all sill bases.	Two rows up to 4 x 4 skids Three rows for 4 x 6 skid (on edge). Three rows for all sill bases.	
Corner strut of end	Corner strut of side	Twentypenny-predrill 12-inch spacing.	Twelvepenny 12-inch spacing.	Predrill holds for twentypenny nails, 75 percent of shank diameter.
Sheathing of side --	Corner strut of end	Eightpenny minimum size 6- to 8-inch spacing.	Sevenpenny minimum size 6- to 8-inch spacing.	

¹ For fastening top to sides and ends use strapping in paragraph 6-24 and illustrated in figure 6-15.

sevenpenny nails. Finally, nail the baffle to the battens using sevenpenny nails.

2. *Holes around the perimeter.* Drill $\frac{3}{4}$ -inch diameter holes 2 inches below the upper frame member spaced evenly around the perimeter of the crate. Drill the holes from the inside out, at a 45° angle to drain outward, then clean the chips and the barrier material from the holes.

3. *Horizontal slots.* Cut the slots one to four inches wide and not over 12 inches long. Cover the opening with $\frac{1}{4}$ or $\frac{3}{8}$ -inch mesh screen cloth and tack or staple hardware cloth in place. Cut from $\frac{1}{4}$ -inch plywood or metal a piece of material large enough to cover the area of the slot. Nail a 2 x 2-inch batten below and on each side of the slot, using sevenpenny nails. Nail the baffle plate to the battens using sevenpenny nails.

(4) *End panels.* The end panels are constructed in the same manner as the sides. Refer to figure 6-55 if the end is over 30 inches wide and figure 6-56 if the end is 30 inches or less (para 6-16b(3)).

(5) *Tops (para 6-16a(5) and fig 6-59).*

(a) *Positioning the frame members.* Position the precut top frame members in a temporary jig in the correct relation to each other.

1. *Narrow tops.* Lay the 2 x 4-inch members flat, with the end frame members inside the side frame members.

2. *Intermediate tops.* Nail the headers to the joists, positioned on their wide faces, with twelvepenny coated nails spaced 2 inches on center. Nail through the headers into the end grain of the top joists.

3. *Wide tops.* Nail the headers to the joists, positioned on edge, with twelvepenny

coated nails. Use two nails for 2 x 4's and three nails for 2 x 6's. Nail through the headers into the end grain of the top joists.

(b) *Plywood to the top frame members.* Place a sheet of $\frac{1}{4}$ -inch of the required plywood over the frame members, with the face grain parallel with the width of the top. Nail the plywood on at least three edges to the frame members with fivepenny coated nails spaced eight inches apart. When joints are required, make them over the frame members or the joists.

(c) *Application of the roofing felt.* Roofing felt, conforming to Specification SS-R-501, should be applied over the plywood and should overlap the edges and ends by a distance equal to the thickness of the end or side sheathing less $\frac{1}{8}$ inch. There should be a minimum 4-inch tape with mastic when a joint is necessary.

(d) *Attachment to the top sheathing boards.*

1. *Narrow tops.* Place the sheathing boards parallel to the width of the top. Nail the sheathing through the plywood to the framing with eightpenny coated nails spaced 3 inches apart.

2. *Intermediate and wide tops.* Place the sheathing boards lengthwise to the top and nail the same as for narrow tops.

c. *Assembly of Lumber Sheathes (Class 1) Crates.*

(1) *Nailed crates.* Type I (nailed) crates are assembled with coated or etched nails and metal straps (table 6-39 and fig 6-60).

(a) *Fastening the sheathing around the perimeter of the base.* The number of nails to be used for fastening the sheathing around the perimeter of the base is based on each 1,000 pounds of gross weight and the wood group used (table 6-40).

Table 6-40. Number of Nails per Each 1,000 Pounds Gross Load for Nailing Sheathing to Base Around Perimeter of Nailed Crate (MIL-C-104)

Type of nail	Size of nail	Wood group of skid		
		II	III	IV
Sinkers or cooler	7d	23	26	19
	8d or 9d	19	21	16
	10d	18	19	14
	12d	15	16	12
Corker	7d	24	26	19
	8d or 9d	17	19	14
	10d	15	16	12
	12d	15	16	12

Note. Nails shall not be less than 1/2 per board (lumber sheathing) and shall neither be more than 3 inches apart nor less than 1-1/2 inches apart.

(b) *Fastening of the tops to the sides and ends.* The tops are fastened to the sides and ends with corner straps and to the sides with tension straps held by anchor plates (fig 6-15). Fabricate the corner straps long enough to permit nailing into the frame members of the sides and ends.

(2) *Bolted crates.* Type II (bolted) crates are assembled with lag bolts or nut sleeve assemblies and metal straps (fig 6-14 and 6-60).

(a) *Fastening the sides and ends to base using lag bolt reinforcing straps.* The size of lag bolts is based upon the gross weight of crate and the size of the skids (table 6-41). Use half the total number on each side and space them evenly along the length of the skids (fig 6-16).

(b) *Fastening the sides to the top.* Use 3/4-inch lag bolts 3 1/2 inches long for fastening the sides to the top (fig 6-61).

1. Place the lag bolts in the end of each joist, as near the center of the joist as possible.

2. For tops without joists, place the lag bolts at the approximate center of the side frame members of the top and space not more than 24 inches apart.

(c) *Fastening of the ends to the top, sides, and base.* Use 3/4-inch lag bolts, 2 1/2 inches long for fastening the ends to the top, and the ends to the sides (fig 6-64).

6-17. Plywood Sheathed (Class 2) Crates (MIL-C-104)

a. *Design Requirements.* Plywood sheathed crates may be constructed of either nailed or bolted assembly.

(1) *Bases.* The construction of bases for plywood sheathed (class 2) crates will adhere to the same requirements for lumber sheathed (class 1) crates (para 6-16a(1) and (2) and fig 6-10 and 6-11).

Table 6-41. Lag Bolts Required to Assemble Sides to Base of Bolted Crates Using Lag Bolt Reinforcing Strap Skids to Group II, III, or IV Woods (MIL-C-104)

Weight of crate and contents (lb)	Size and number of lag bolts ¹		
	3/8 x 3-inch (3 x 3 or 3 x 4-inch skids)	1/2 x 4-inch (4 x 4-inch skids)	5/8 x 4-inch (4 x 6-inch skids)
2,000	6	6	6
3,000	10	6	6
4,000	14	8	6
6,000	20	12	8
8,000		16	10
10,000		18	12
12,000		22	14
14,000		26	16
16,000		30	18
18,000		32	22
20,000		36	24
24,000			28
28,000			32
32,000			36
36,000			42
40,000			46

¹ Use one-half the number on each side.

Maximum spacing— 3/8 x 3—16 inches on center

1/2 x 4—20 inches on center

5/8 x 4—20 inches on center

Minimum number—three per side, two per end.

(2) *Sides.* The sides of plywood sheathed (class 2) crates consist of upper and lower frame members, vertical struts, horizontal braces, joist supports, and lag screw reinforcing straps, when the crate is of bolted assembly construction.

(a) *Type and number of panels.* Determine the type of side panels from the inside height of the crate. The number of panels depends upon the length of the crate (table 6-42 and fig 6-62).

(b) *Selection of members.* Calculate the requirements for the upper and lower frame members in the same manner as for lumber sheathed crates (see para 6-16a(3) (b) and tables 6-35 and 6-43 through 6-52 for the sizes).

1. *Diagonals.* Diagonals are not required for plywood sheathed crates.

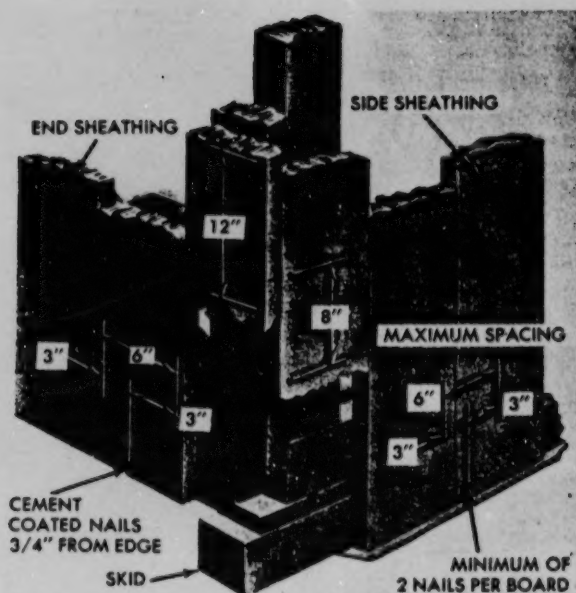
2. *Horizontal braces.* Horizontal braces for type B and C panels are the same thickness as the struts and are four inches wide.

3. *Joist supports,* (para. 6-16a(3) (g) and fig 6-56).

(c) *Liners.* Liners are not required for plywood sheathed crates.

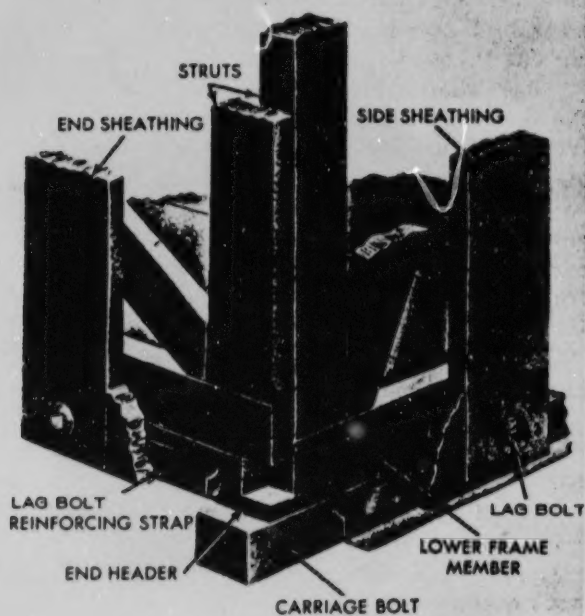
(d) *Sheathing.* Use 1/4-inch plywood sheathing for net loads up to 300 pounds; 3/8-inch for net loads up to 10,000 pounds; and 1/2-inch for net loads over 10,000 pounds. Apply plywood with the face grain vertically. When specified, the face grain may be placed horizontally on crates 4 feet

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NOTE: USE TWO ROWS OF NAILS IN SKIDS UP TO 4" x 4" AND 3 ROWS FOR 4" x 6" SKIDS (ON EDGE) AND ALL SILL-TYPE BASES.

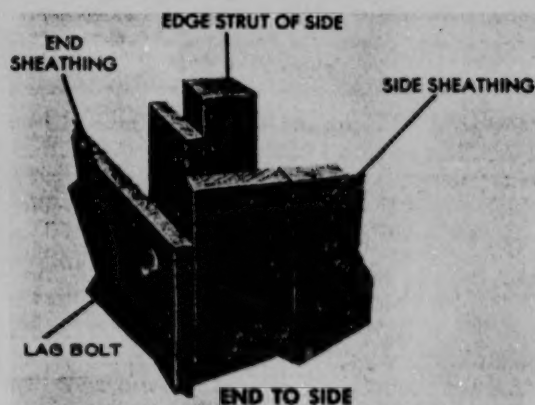
NAILED CRATE



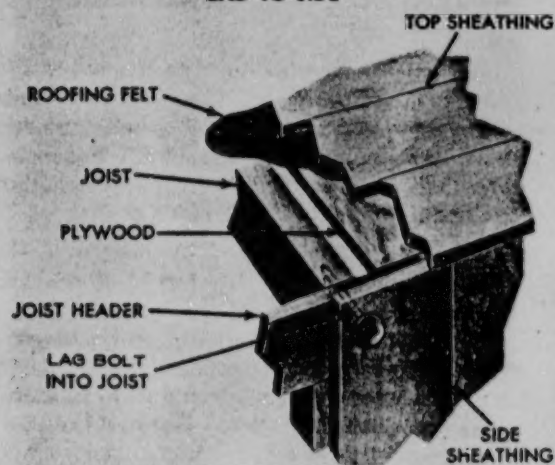
BOLTED CRATE

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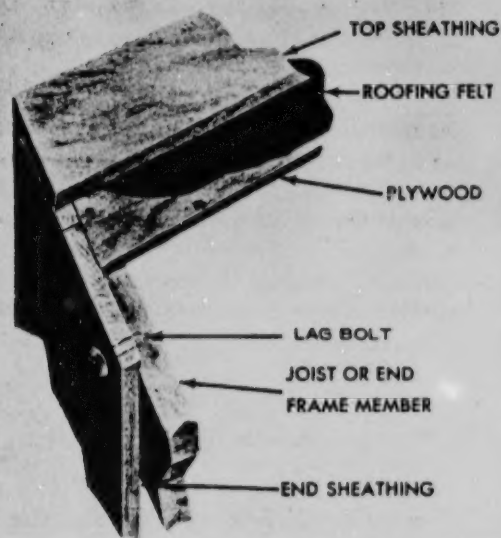
Figure 6-60. Detail view of lower corners of nailed and bolted crates.



END TO SIDE



SIDE TO TOP

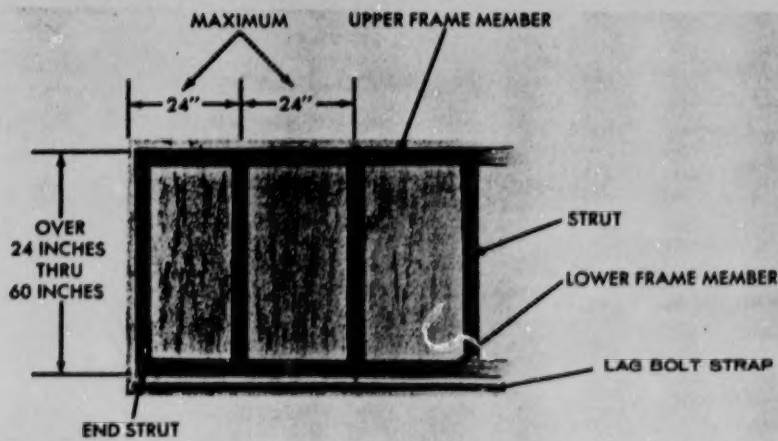


END TO TOP

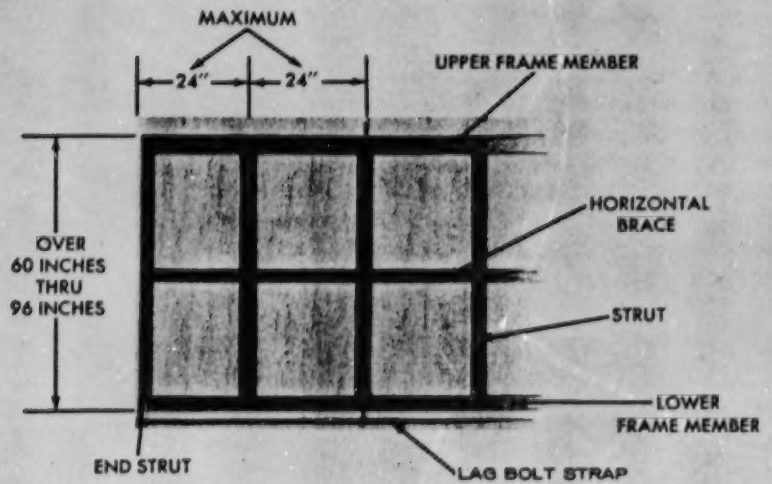
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Figure 6-81. Detail assembly of bolted crate.

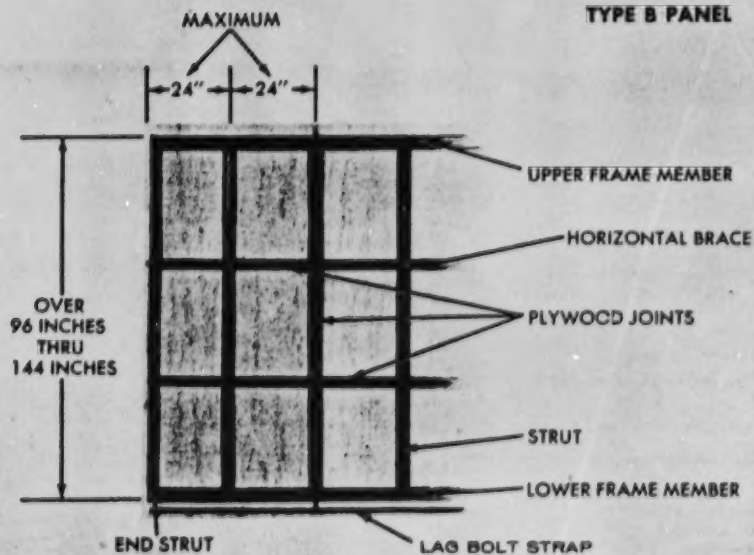
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TYPE A PANEL



TYPE B PANEL



TYPE C PANEL

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Figure 6-62. Type and number of plywood panels.

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Table 6-42. Type of Panels for Plywood Sheathed Crates (MIL-C-104)

Inside height of crate	Type of panel	Framing pattern
Over 24-60 inches	A	Fig 6-62
Over 60-96 inches	B	Fig 6-62
Over 96-144 inches	C	Fig 6-62

or less in height. Horizontal joints in plywood sheathing are not permitted in type A side panels; not desirable, but permitted in type B panels; and shall be permitted in type C panels.

e. *Lag bolt reinforcing straps.* Use lag bolt reinforcing straps on all bolted (demountable) crates (fig 6-16). These straps should extend the full length of each panel of the sides and ends (para 6-16a(3)(k)).

(3) *Ends.* The ends of plywood sheathed (Class 2) crates consists of the same members as indicated for sides. Compute the type and number of end panels in the same way as for the sides (fig 6-62). The requirements for the upper and lower members and struts are the same as for the sides (para 6-16a(3) (c) and (d) and tables 6-35 and 6-43 through 6-52).

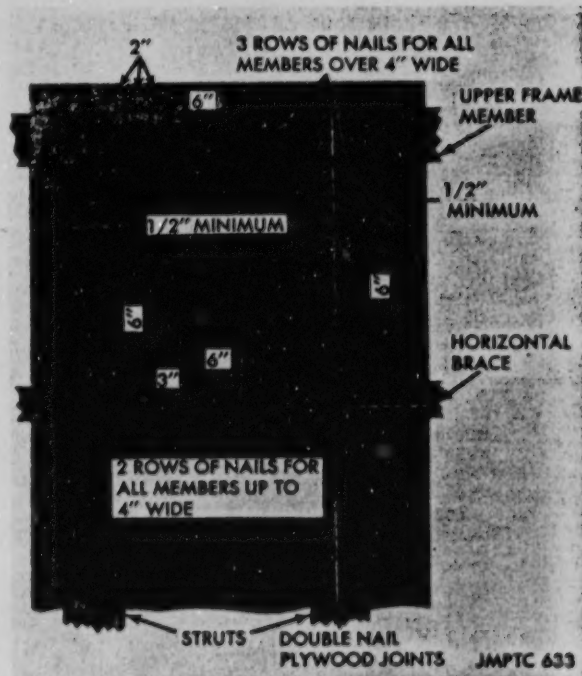


Figure 6-63. Fabrication nailing (plywood sheathing).

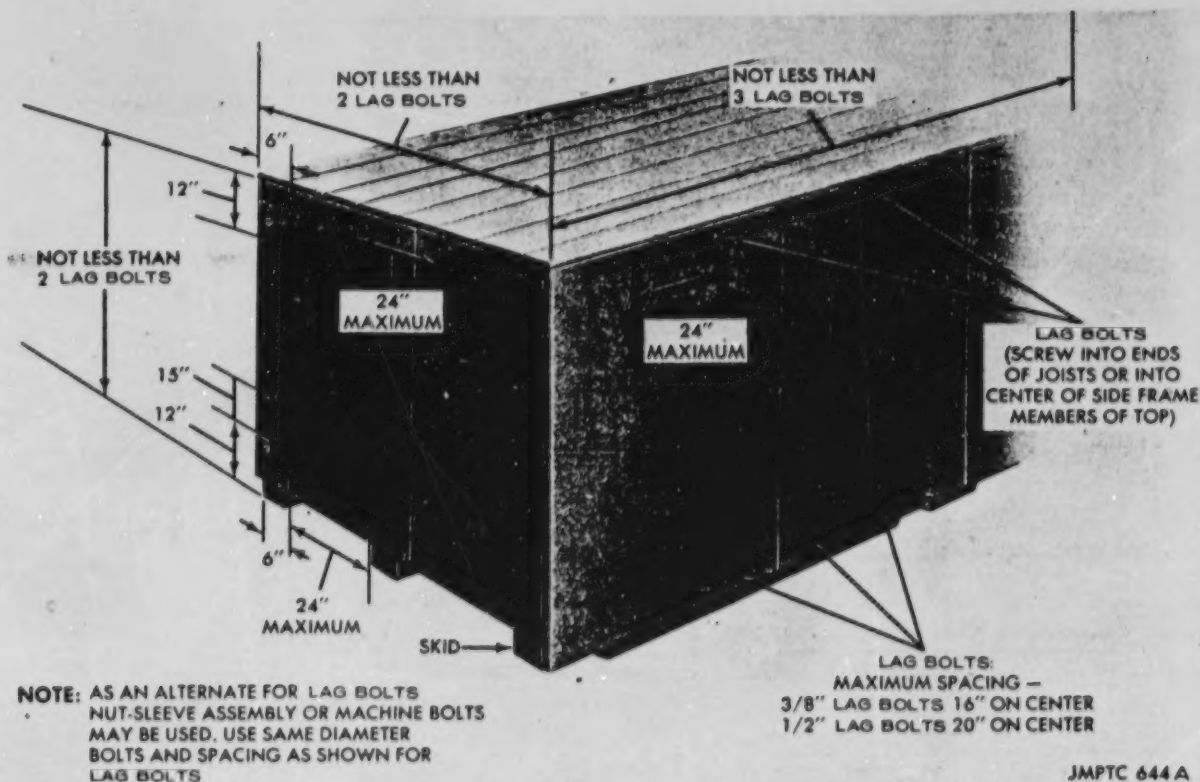


Figure 6-64. Assembly of the bolted crate.

b. Fabrication of Plywood Sheathed (Class 2) Crates. Secure the sheathing to the framing members with nails driven through the plywood into the framing members (fig 6-63). Use a nail long enough to allow a minimum $\frac{1}{2}$ -inch clinch. For nailing joist supports, refer to paragraph 6-16a(3) (j) and use ninepenny nails as illustrated in figure 6-56.

c. Assembly of Plywood Sheathed (Class 2) Crates.

(1) *Nailed assembly.* Assemble plywood sheathed nailed crates in the same manner as lumber sheathed (class 1) crates (para 6-16c(1) and fig 6-60). Nail sizes are specified in table 6-39.

(2) *Bolted assembly.* Assemble plywood sheathed bolted crates in the same manner as lumber sheathed (Class 1) Type II (bolted) crates (para 6-16c(2) and fig 6-60, 6-61, and 6-64).

6-18. Crate, Slotted Angle, Steel or Aluminum (MIL-C-9897)

a. Design Requirements. The slotted angle crate is designed to permit rapid fabrication of a crate through assembly of slotted angle steel or aluminum with nuts, bolts, and lockwashers and disassembly and reuse of component material.

b. Classification. The following classifications have been established for this crate (fig 6-8):

(1) Types.

(a) *Type I*—crate, slotted angle, steel or aluminum, open.

(b) *Type II*—crate, slotted angle, steel or aluminum, fully inclosed or sheathed with solid material.

(2) Styles.

(a) *Style A*—crate, slotted, angle, steel, or aluminum, without skids or rubbing strips.

(b) *Style B*—crate, slotted angle, steel, with skid blocks or skids with rubbing strips and provisions for forklift truck handling.

(3) Grades.

(a) *Grade 1.* Crate for domestic and oversea shipments intended for outside or indeterminate storage.

(b) *Grade 2.* Crate for domestic and oversea shipments intended for inside or protected storage.

c. Use. These crates are suitable for—

(1) Packing lightweight, bulky items, including airframe components.

(2) Oversea and domestic air and surface shipments.

(3) Packing items requiring rigid blocking and bracing assemblies, such as support panels, cushioned saddles, solid and slat cradles, specially designed brackets, yoke panel assemblies, etc.

(4) Adaptation of suspension systems or shock mounts for shock absorption.

(5) Packing repairable, returnable items where a desirable light-weight, reusable container is specified.

d. Materials.

(1) Slotted metal angles.

(a) This material comes in either steel or aluminum. There are three different sizes of slotted metal angles, variations being based on the size of the flanges and the thickness of the metal used in fabricating the angles. The slotted angle material shall conform to Specification MIL-S-21041, use table 6-35 as a guide for the selection of slotted angle based on size of crate and weight of load.

(b) Steel slotted angle material for Grade 1 crates shall have a zinc protective coating. Steel slotted angle material for Grade 2 crates shall be treated with a primer or a phosphatized base and a baked-on synthetic enamel of high grade commercial quality. The color shall be DOD Gray, unless otherwise specified, in accordance with Federal Standard 595.

(c) The hole pattern for the $1\frac{1}{2}$ -inch by $1\frac{1}{2}$ -inch angle shall be of such a design as to provide one line of holes or slots in each flange. The $1\frac{1}{2}$ -inch by $2\frac{1}{4}$ -inch angle shall have one line of holes or slots in the narrow flange and two lines of holes or slots in the wide flange. The $1\frac{1}{2}$ -inch by 3-inch angle shall have one line of holes or slots in the narrow flange and three lines of holes or slots in the wide flange. The hole pattern shall be of continual repetition and shall be visually indexed at 3-inch intervals.

(d) Occasionally, it may be necessary to splice pieces. When this occurs, either the lap or butt splice may be made. The bolting pattern shown in figure 6-65 will be followed, when possible, in making the splices.

(2) Bolts and nuts.

(a) Bolts and nuts used in joining slotted angle frame members of the crate shall conform to Specification MIL-S-21041, except that nuts shall conform to MS51922 with the exception that $\frac{5}{16}$ nuts shall be .551 to .564 inches across the flats.

(b) Bolts and nuts used in attaching sheathing and wood members of the crate (and any wood blocking and bracing therein) shall be

Table 6-43. Panel Member Selection Table for 1,000 Pounds, Net Load (MIL-C-104)

Length (ft)	Members	4 ft width						6 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																							2x4	2x4
8	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																					1x6	2x4	2x4	
10	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																					1x6	2x4	2x4	
12	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																					1x6	2x4	2x4	
16	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																1x6				1x6		1x6	2x4	2x4
20	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																1x6				1x6		1x8	2x4	2x4
24	Upper frame member	(²)						(²)						(²)					2x4	(²)				2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts									1x6					1x6		1x6		2x4		1x6		1x8	2x4	2x4
	Diagonal																1x6					1x6		1x6	1x6
28	Upper frame member	(²)						(²)						(²)					2x4	(²)				2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts									1x6					1x6		1x8		2x4		1x6		2x4	2x4	2x4
	Diagonal																1x6		1x6				2x4	1x6	1x4
32	Upper frame member	(²)						(²)						(²)					2x4	(²)	1x6		2x4	2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts									1x6					1x6		2x4		2x4				2x4	2x4	2x4
	Diagonal			1x6						1x6		1x6			2x4		2x4		2x4		1x6	1x6	2x4	2x4	2x4

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.
Note. All blank spaces are 1x4's.

Table 6-44. Panel Member Selection for 2,000 Pounds, Net Load (MIL-C-104)

Length (ft)	Members	4 ft width						6 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
8	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
10	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
12	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
16	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
20	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
24	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Upper frame member	(²)	---	---	---	---	---	(²)	---	---	---	---	---	(²)	1x6	---	---	---	2x4	(²)	1x6	---	---	2x4	2x4
28	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
32	Upper frame member	(²)	1x6	---	---	2x4	---	(²)	1x6	---	---	---	---	(²)	1x6	1x6	2x4	---	2x4	(²)	2x4	1x6	2x4	2x4	2x4
	Lower frame member	---	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.
Note. All blank spaces are 1x4's.

Table 6-45. Panel Member Selection Table for 4,000 Pounds, Net Load (MIL-C-104)

Length (ft)	Members	4 ft width						6 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																						1x6		
8	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					1x6	2x4
	Diagonal										1x6						1x6						1x6		1x6
10	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal				1x6						1x6						2x4						2x4		2x4
12	Upper frame member																		2x4					2x4	2x4
	Lower frame member																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal				1x6						1x6						1x6						2x4		1x6
16	Upper frame member	1x6						1x6						1x6			2x4		2x4	1x6			2x4	2x4	2x4
	Lower frame member																2x4		2x4				2x4	2x4	2x4
	Struts																2x4		2x4				2x4		1x6
	Diagonal				1x6						1x6					2x4		2x4		2x4		2x6		2x4	2x4
20	Upper frame member	1x6						1x6									2x4		2x4				2x4	2x4	2x4
	Lower frame member																2x4		2x4				2x4	2x4	2x4
	Struts																2x4		2x4				2x4	1x6	2x4
	Diagonal				1x6						1x6			(²)	1x6	1x6	2x4		2x4	(²)	1x6	1x6	2x4	2x4	2x4
24	Upper frame member	(²)	1x6					(²)	1x6		2x4						2x4		2x4				2x4	2x4	2x4
	Lower frame member										2x4					1x6		2x4				1x6	2x4	2x4	2x4
	Struts										2x4						2x4		2x4				1x6	2x4	2x4
	Diagonal				1x6						2x4		1x6	(²)	1x6	1x6	2x4		2x4	(²)	1x6	1x6	2x4	2x4	2x4
28	Upper frame member	(²)	1x6					(²)	1x6		2x4						2x4		2x4				2x4	2x4	2x4
	Lower frame member										2x4						2x4		2x4				2x4	2x4	2x4
	Struts										2x4					1x6		2x4				1x6	2x4	2x4	2x4
	Diagonal				1x6						2x4		1x6				2x4		2x4				1x6	2x4	2x4
32	Upper frame member	(²)	2x4		2x4			(²)	2x4	1x6	2x4			(²)	2x6	1x6	2x4		2x4	(²)	2x6	1x6	2x4	2x4	2x4
	Lower frame member				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4					1x6		2x4				1x6	1x6	2x4	2x4
	Diagonal				2x4						2x4		1x6			1x6	2x4		2x4				1x6	2x4	2x6

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.

Note. All blank spaces are 1x4's.

Table 6-46. Pound Member Selection Table for 6,000 Pounds, Net Load (MIL-C-104)

L Length (ft)	Members	4 ft width						6 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	2x4	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	2x4	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	2x4	2x4	2x4
	Diagonal	---	---	---	1x6	---	---	---	---	---	1x6	---	---	---	---	---	1x6	---	2x4	---	---	---	2x4	2x4	2x4
8	Upper frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	1x6	---	1x6	---	---	---	---	---	1x6	---	---	1x6	---	---	1x6	---	---	---	1x6	2x4	2x4
10	Upper frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	---	---	---	---	---	---	1x6	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
12	Upper frame member	1x6	---	---	2x4	---	---	1x6	---	---	---	---	---	1x6	---	---	---	---	2x4	1x6	---	---	---	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	---	---	---	---	---	---	1x6	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
16	Upper frame member	2x6	---	---	2x4	---	---	2x6	---	---	---	---	---	2x6	---	---	---	---	2x4	2x6	---	---	---	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	---	---	---	---	---	---	1x6	---	---	---	---	---	2x4	---	1x6	---	---	2x4	2x4
20	Upper frame member	2x6	1x6	---	2x4	---	---	2x6	1x6	---	---	---	---	2x6	1x6	---	---	---	2x4	2x6	1x6	---	---	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	1x6	1x6	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	1x6	---	---	1x6	2x4	---	1x6	---	---	1x6	2x4	1x6	2x4	---	1x6	---	---	2x4	2x4
24	Upper frame member	(²)	2x4	1x6	2x4	---	---	(²)	2x4	1x6	2x4	---	2x4	(²)	2x6	1x6	2x4	2x4	2x4	(²)	2x6	1x6	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	1x6	2x4	---	1x6	---	---	---	2x4	---	1x6	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	1x6	---	---	1x6	2x4	1x6	2x4	---	1x6	2x4	2x4	2x4	2x4	---	1x6	---	---	2x4	2x4
28	Upper frame member	(²)	2x4	1x6	2x4	---	---	(²)	2x4	1x6	2x4	---	2x4	(²)	2x6	1x6	2x4	2x4	2x4	(²)	2x6	2x4	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	---	2x4	---	1x6	---	---	1x6	2x4	1x6	2x4	---	1x6	2x4	2x4	2x4	2x4	---	1x6	---	---	2x4	2x6
32	Upper frame member	(²)	2x6	1x6	2x4	---	2x4	(²)	2x6	1x6	2x4	---	2x4	(²)	2x6	2x4	2x4	2x4	2x4	(²)	2x6	2x4	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Struts	---	---	---	2x4	---	---	---	---	---	---	---	---	---	---	---	---	---	2x4	---	---	---	---	2x4	2x4
	Diagonal	---	---	1x6	2x4	1x6	2x4	---	---	1x6	2x4	1x6	2x4	---	---	2x4	2x4	2x4	2x6	---	1x6	2x4	2x6	2x6	2x6

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.

Note. All blank spaces are 1x4's.

DLAM 4145.2, Vol II/TM 38-230-2/NAVSUP PUB 503, Vol II/AFIP 71-16/MCO P4030.21C

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Table 6-47. Panel Member Selection for 8,000 Pounds, Net Load (MIL-C-104)

Length (ft)	Members	4 ft width						6 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Lower frame member				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Diagonal			1x6	2x4		1x6			1x6	2x4	1x6	1x6			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4
8	Upper frame member	1x6			2x4		2x4	1x6			2x4		2x4	1x6		2x4	2x4		2x4	1x6		2x4	2x4	2x4	2x4
	Lower frame member				2x4		2x4				2x4		2x4			2x4	2x4		2x4			2x4	2x4	2x4	2x4
	Struts				2x4		2x4				2x4		2x4			2x4	2x4		2x4			2x4	2x4	2x4	2x4
	Diagonal			1x6	2x4		2x4			1x6	2x4		2x4			2x4	2x4		2x4			2x4	2x4		2x4
10	Upper frame member	1x6			2x4			1x6			2x4			1x6			2x4		2x4	1x6		2x4	2x4	2x4	2x4
	Lower frame member				2x4						2x4						2x4		2x4			2x4	2x4	2x4	2x4
	Struts				2x4						2x4		1x6				2x4	1x6	2x4				2x4	2x4	2x4
	Diagonal				2x4		1x6			1x6	2x4		1x6			1x6	2x4	1x6	1x6			2x4	2x4	1x6	2x4
12	Upper frame member	2x6			2x4			2x6			2x4		2x4	2x6			2x4		2x4	2x6		2x4	2x4	2x4	2x4
	Lower frame member				2x4						2x4		2x4				2x4		2x4			1x6	2x4	2x4	2x4
	Struts				2x4						2x4		2x4				2x4	1x6	2x4			1x6	2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4			2x4	2x4	2x4	2x4
16	Upper frame member	2x6			2x4			2x6	1x6		2x4		2x4	2x6	1x6		2x4		2x4	2x6	1x6	2x4	1x4	2x4	2x4
	Lower frame member				2x4						2x4		2x4				2x4		2x4			2x4	2x4	2x4	2x4
	Struts				2x4						2x4		2x4				2x4	1x6	2x4		1x6		2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4		1x6	1x6	2x4	2x4	2x4
20	Upper frame member	2x8	1x6		2x4			2x8	1x6		2x4		1x6	2x8	1x6	2x4	2x4	2x4	2x4	2x8	2x4	2x4	2x4	2x4	2x4
	Lower frame member				2x4						2x4		2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts				2x4						2x4		1x6			2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6			1x6	2x4	1x6	1x6			1x6	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x6
24	Upper frame member	(²)	2x6	1x6	2x4		2x4	(²)	2x6	1x6	2x4	2x4	2x4	(²)	2x6	2x4	2x4	2x4	2x4	(²)	2x6	2x4	2x4	2x4	2x4
	Lower frame member				2x4		2x4				2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts				2x4		2x4				2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x6
	Diagonal			1x6	2x4	1x6	2x4		1x6	1x6	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x6	2x6	2x6
28	Upper frame member	(²)	2x6	2x4	2x4	2x4	2x4	(²)	2x6	2x4	2x4	2x4	2x4	(²)	2x6	2x4	2x4	1x6	1x6	(²)	2x6	2x6	2x6	2x4	2x4
	Lower frame member			2x4	2x4	2x4	2x4				2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts			2x4	2x4	2x4	2x4				2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal			2x4	2x4	2x4	2x4			1x6	2x4	2x4	2x6		1x6	2x4	2x4	2x4	2x6		1x6	2x4	2x6	2x6	2x6
32	Upper frame member	(²)	2x8	1x6	2x4		2x4	(²)	2x8	2x6	2x4	2x4	2x4	(²)	2x8	2x6	2x6	2x4	2x4	(²)	2x8	2x6	2x6	2x4	2x4
	Lower frame member				2x4		2x4				2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts				2x4		2x4				2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x6	2x6	2x6		1x6	2x4	2x6	2x6	2x6

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.

Note. All blank spaces are 1x4's.

Table 6-48. Panel Member selection Table for 10,000 Pounds, Net Load (MIL-C-104)

Length (ft)	Members	4 ft width						8 ft width						8 ft width						10 ft width					
		Height (ft)						Height (ft) ¹						Height (ft) ¹						Height (ft)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame member	---	---	---	2x4	---	2x4	---	---	---	2x4	---	2x4	---	---	2x4	2x4	---	2x4	---	---	2x4	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	2x4	---	---	---	2x4	---	2x4	---	---	2x4	2x4	---	2x4	---	---	2x4	2x4	2x4	2x4
	Struts	---	---	---	2x4	1x6	2x4	---	---	1x6	2x4	1x6	2x4	---	1x6	2x4	2x4	1x6	2x4	---	1x6	2x4	2x4	2x4	2x4
	Diagonal	---	---	1x6	2x4	1x6	2x4	---	---	1x6	2x4	1x6	2x4	---	1x6	2x4	2x4	1x6	2x4	---	1x6	2x4	2x4	2x4	2x4
8	Upper frame member	1x6	---	2x4	2x4	---	2x4	1x6	---	2x4	2x4	---	2x4	1x6	---	2x4	2x4	---	2x4	1x6	---	2x4	2x4	2x4	2x4
	Lower frame member	---	---	2x4	2x4	---	2x4	---	---	2x4	---	---	---	---	---	2x4	2x4	---	2x4	---	---	2x4	2x4	2x4	2x4
	Struts	---	---	2x4	2x4	1x6	2x4	---	---	2x4	2x4	1x6	2x4	---	1x6	2x4	2x4	1x6	2x4	---	1x6	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x6
10	Upper frame member	1x6	---	---	2x4	---	2x4	1x6	---	---	2x4	---	2x4	1x6	---	---	2x4	---	2x4	2x4	1x6	---	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	2x4	---	---	---	2x4	---	2x4	---	---	---	2x4	---	2x4	---	---	2x4	2x4	2x4	2x4
	Struts	---	---	1x6	2x4	1x6	2x4	---	---	1x6	2x4	1x6	2x4	---	---	1x6	2x4	1x6	2x4	---	---	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	1x6	2x4	1x6	2x4	1x6	1x6	1x6	2x6	1x6	2x4	1x6	1x6	1x6	2x6	1x6	2x4	1x6	1x6	2x4	2x6	2x4	2x4
12	Upper frame member	2x6	---	---	2x4	---	2x4	2x6	---	2x4	2x4	2x4	2x4	2x6	---	2x4	2x4	2x4	2x4	2x6	---	2x4	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	2x4	---	---	2x4	---	---	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4
	Struts	---	---	1x6	2x4	1x6	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	1x6	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x4	2x4	2x4
16	Upper frame member	2x8	1x6	---	2x4	---	2x4	2x8	1x6	2x4	2x4	2x4	2x4	2x8	1x6	2x4	2x4	2x4	2x4	2x8	1x6	2x4	2x4	2x4	2x4
	Lower frame member	---	---	---	2x4	---	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4
	Struts	---	---	---	2x4	1x6	2x4	---	---	2x4	2x4	2x4	2x4	---	1x6	2x4	2x4	2x4	2x4	---	1x6	2x4	2x4	2x4	2x4
	Diagonal	1x6	1x6	1x6	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x6	2x4	2x4	1x6	1x6	2x4	2x6	2x6	2x4
20	Upper frame member	2x10	2x4	2x4	2x4	---	2x4	2x10	2x6	2x4	2x4	2x4	2x4	2x10	2x6	2x4	2x4	2x4	2x4	2x10	2x6	2x4	2x4	2x4	2x4
	Lower frame member	1x6	---	2x4	2x4	---	2x4	1x6	---	2x4	2x4	2x4	2x4	1x6	---	2x4	2x4	2x4	2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Struts	---	---	2x4	2x4	1x6	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x6
	Diagonal	1x6	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x6	2x4	2x6	1x6	2x4	2x4	2x6	2x6	2x6
	Upper frame member	(²)	2x6	2x4	2x4	2x4	2x4	(²)	2x6	2x6	2x4	2x4	2x4	(²)	2x6	2x6	2x4	2x4	2x4	(²)	2x8	2x6	2x4	2x4	2x4
	Lower frame member	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Struts	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	2x4	2x4	2x4	2x4	1x6	2x4	2x6	2x6	2x6	2x6	---	1x6	2x4	2x6	2x6	2x6	---	2x4	2x4	2x6	2x6	2x6
	Upper frame member	(³)	2x6	2x4	2x4	2x4	2x4	(³)	2x6	2x6	2x4	2x4	2x4	(³)	2x8	2x6	2x6	2x4	2x4	(³)	2x8	2x6	2x6	2x6	2x4
	Lower frame member	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Struts	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	2x4	2x4	2x4	2x4	---	1x6	2x4	2x6	2x6	2x6	---	2x4	2x4	2x6	2x6	2x6	---	2x4	2x4	2x6	2x6	2x6
	Upper frame member	(³)	2x8	2x6	2x6	2x4	2x4	(³)	2x6	2x6	2x6	2x4	2x4	(³)	2x10	2x6	2x6	2x4	2x4	(³)	2x10	2x6	2x6	2x4	2x4
	Lower frame member	---	---	2x4	2x4	2x4	2x4	---	---	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Struts	---	1x6	2x4	2x4	2x4	2x4	---	1x6	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4	---	2x4	2x4	2x4	2x4	2x4
	Diagonal	---	1x6	2x4	2x6	2x4	2x6	---	1x6	2x4	2x6	2x6	2x6	---	2x4	2x4	2x6	2x6	2x6	---	2x4	2x6	2x6	2x6	2x6

¹Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joist supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

²Crates require special design.

Note. All blank spaces are 1x4's.

DLAM 4145.2, Vol II/TM 38-230-2/NAVSUP PUB 503, Vol II/AF 71-16/MCO P4030.21C

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Table 6-49. Panel Member Selection Table for 15,000 Pounds, Net Load¹ (MIL-C-104)

Length (ft)	Members	4 ft width					6 ft width					8 ft width					10 ft width				
		Height (ft)					Height (ft) ¹					Height (ft) ¹					Height (ft)				
		4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
6	Upper frame member																				
	Lower frame member														2x6	2x6			2x6	2x6	2x6
	Struts														2x6	2x6					
	Diagonal			(*)	2x6	2x6			(*)	2x6	2x6		(*)	(*)	2x6	2x6		(*)	(*)	2x6	2x6
8	Upper frame member																				
	Lower frame member														2x6	2x6			2x6	2x6	2x6
	Struts									(*)	2x6			(*)	2x6	2x6		(*)	2x6	2x6	2x6
	Diagonal		(*)	2x6		2x6		(*)	2x6		2x6		(*)	2x6		2x6		(*)	2x6	(*)	2x6
10	Upper frame member																				
	Lower frame member														2x6	2x6			2x6	2x6	2x6
	Struts									(*)	2x6	2x6			2x6	2x6			2x6	2x6	2x6
	Diagonal		2x6	2x6	(*)			2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
12	Upper frame member																				
	Lower frame member					2x6			2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Struts								2x6	2x6	2x6		2x6	2x6	2x6	2x6		(*)	2x6	2x6	2x6
	Diagonal											2x6	2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
16	Upper frame member											2x6					2x6				
	Lower frame member														2x6	2x6			2x6	2x6	2x6
	Struts				2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6
	Diagonal			2x6	2x6	2x6			2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
20	Upper frame member	2x6					2x6					2x6					2x6				
	Lower frame member														2x6	2x6				2x6	2x6
	Struts				2x6	2x6				2x6	2x6				2x6	2x6				2x6	2x6
	Diagonal		2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
24	Upper frame member	**2x6	(*)				**2x6	2x6				**2x6	2x6	2x6	2x6		**2x6	2x6	2x6	2x6	2x6
	Lower frame member																				
	Struts				2x6	2x6				2x6	2x6			(*)		2x6		(*)		2x6	2x6
	Diagonal		2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
28	Upper frame member	**2x6	2x6	(*)			**2x6	2x6	2x6			**2x8	2x6	2x6	2x6		**2x8	2x6	2x6	2x6	2x6
	Lower frame member																				
	Struts							(*)						(*)		2x6			(*)		
	Diagonal		(*)	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8
32	Upper frame member	**2x8	2x6	2x6			**2x8	*2x6	*2x6			**2x8	*2x6	*2x6	2x6	(*)	**2x8	*2x6	*2x6	2x6	2x6
	Lower frame member		(*)				(*)					(*)		(*)			(*)		(*)		
	Struts							(*)						(*)					(*)		
	Diagonal		(*)	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x8	2x8	2x8

¹ The above are for uniform loads, but apply also to concentrated loads except where an asterisk is shown. Where one asterisk is shown, increase the member size to the next larger size as a blank (standing for a 2x4) to a 2x6, a 2x6 to a 2x8, etc., and where two asterisks are shown increase the member size to the second larger size as a 2x6 to a 2x10 or a 2x8 to a 2x12.

Note. All blank spaces are 2x4's.

Table 6-50. Panel Member Selection Table for 20,000 Pounds, Net Load¹ (MIL-C-104)

Length (ft)	Members	4 ft width					6 ft width					8 ft width					10 ft width				
		Height (ft)					Height (ft) ¹					Height (ft) ¹					Height (ft)				
		4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
6	Upper frame member																				
	Lower frame member																				
	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	*2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6
							(*)	(4)				2x6	2x6				2x6	2x6			
10	Struts				2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Diagonal				2x6	*2x6	2x6	2x6	2x6	2x6	2x8	2x6	*2x6	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x8
	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
	Lower frame member																				
	Struts		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
12	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x8	2x6	2x6
	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
	Lower frame member																				
	Struts		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	*2x6	2x6	2x6	2x6	2x6	2x8	*2x6
16	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6	2x6
	Lower frame member																				
	Struts	(*)		2x6	2x6	2x6	(*)		2x6	2x6	2x6	(*)		2x6	2x6	2x6	(*)		2x6	2x6	2x8
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x8	2x6	2x6	2x6	2x8	2x8	2x6
	Upper frame member	*2x6	2x6	2x6	2x6	2x6	*2x6	2x6	2x6	2x6	2x6	*2x6	2x6	2x6	2x6	2x6	*2x6	2x6	2x6	2x6	2x6
20	Lower frame member																				
	Struts				2x6	2x6				2x6	2x6				2x6	2x8				2x8	2x8
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x6	2x6	2x6	2x8	2x8	2x8
	Upper frame member	*2x8	*2x6	2x6	2x6	2x6	*2x8	*2x6	2x6	2x6	2x6	*2x8	*2x6	2x6	2x6	2x6	*2x8	*2x6	2x6	2x6	2x6
	Lower frame member						(*)					(*)					(*)				
24	Struts	(*)	(*)		2x6	2x6	(*)	(*)		2x6	2x6	(*)	(*)		2x6	2x8	(*)	(*)		2x8	2x8
	Diagonal	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x8	*2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8
	Upper frame member	*2x8	*2x6	*2x6	2x6	2x6	*2x8	*2x6	*2x6	2x6	2x6	*2x6	*2x6	*2x6	2x6	2x6	*2x8	*2x6	*2x6	2x6	2x6
	Lower frame member						(*)					(*)					(*)				
	Struts			(*)				(*)					(*)	(*)				(*)	(*)		
28	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8
	Upper frame member	2x10	*2x6	*2x6	2x6	2x6	2x10	2x8	*2x6	2x6	2x6	2x10	*2x8	*2x6	2x6	2x6	2x10	*2x8	*2x8	2x6	2x6
	Lower frame member																				
	Struts			(*)				(*)					(*)	(*)				(*)	(*)		
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8
32	Upper frame member	2x10	*2x6	*2x6	2x6	2x6	2x10	2x8	*2x6	2x6	2x6	2x10	*2x8	*2x6	2x6	2x6	2x10	*2x8	*2x8	2x6	2x6
	Lower frame member																				
	Struts			(*)				(*)					(*)	(*)				(*)	(*)		
	Diagonal	2x6	2x6	2x8	2x6	*2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	*2x8

¹ The above sizes are for uniform loads, but apply also to concentrated loads except where an asterisk is shown. Where one asterisk is shown, increase the member size to the next larger size as a blank (standing for a 2x4) to a 2x6, a 2x6 to a 2x8, etc., and where two asterisks are shown increase the member size to the second larger size as a 2x6 to a 2x10 or a 2x8 to a 2x12. Where figure appear in bold faced type, a special design is required for a concentrated load.

Note. All blank spaces are 2x4's.

Table 6-51. Panel Member Selection Table for 25,000 Pounds, Net Load¹ (MIL-C-104)

Length (ft)	Members	4 ft width					6 ft width					8 ft width					10 ft width					
		Height (ft)					Height (ft) ¹					Height (ft) ¹					Height (ft)					
		4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	
6	Upper frame member	2x6	2x6				2x6	2x6				2x6	2x6					2x6	2x6			
	Lower frame member																					
	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	
8	Diagonal	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	
	Upper frame member	2x6	2x6	(*)			2x6	2x6	(*)			2x6	2x6	(*)			2x6	2x6	(*)			
	Lower frame member																					
10	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x6	*2x6	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	
	Diagonal	2x6	2x8	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x6	2x10	
	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			
12	Lower frame member																					
	Struts		2x6	2x6	2x6	2x8		2x6	2x8	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8	
	Diagonal	2x6	2x6	*2x8	2x6	2x6	2x6	2x6	*2x8	2x8	2x8	2x6	2x6	*2x8	2x8	2x8	2x8	2x8	*2x8	2x8	2x8	
16	Upper frame member	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	
	Lower frame member																					
	Struts	(*)		2x8	2x8	2x8	(*)		2x8	2x8	2x8	(*)		2x8	2x8	2x8	(*)		2x8	2x8	2x8	
20	Diagonal	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	
	Upper frame member	*2x8	2x6	2x6	2x6	2x6	*2x8	2x6	2x6	2x6	2x6	*2x8	2x6	2x6	2x6	2x6	*2x8	2x6	2x6	2x6	2x6	
	Lower frame member																					
24	Struts				2x8	2x8				2x8	2x8				2x8	2x8				2x8	2x8	
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	
	Upper frame member	2x8	*2x6	2x6	2x6	2x6	2x10	*2x8	2x8	2x8	2x6	2x10	*2x8	2x8	2x8	2x6	2x10	*2x8	2x8	2x8	2x6	
28	Lower frame member																					
	Struts		(*)		2x8	2x8		(*)		2x8	2x8		(**)		2x8	2x8		(**)		2x8	2x6	
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x10	
32	Upper frame member	2x10	*2x8	*2x6	2x6	2x6	2x10	*2x8	*2x8	2x8	2x6	2x10	*2x8	*2x8	2x8	2x6	2x8	*2x8	*2x8	2x8	2x6	
	Lower frame member																					
	Struts			(**)					(**)					(**)		2x6		(**)		2x6	2x6	
32	Diagonal	2x8	2x8	*2x8	2x8	2x8	2x8	2x8	2x10	2x8	*2x8	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10	

¹ The above sizes are for uniform loads, but apply also to concentrated loads except where an asterisk is shown. Where one asterisk is shown, increase the member size to the next larger size as a blank (standing for a 2x4) to a 2x6, a 2x6 to a 2x8, etc., and where two asterisks are shown increase the member size to the second larger size as a 2x6 to a 2x10 or a 2x8 to a 2x10. Where figures appear in bold faced type, a special design is required for a concentrated load.

Note. All blank spaces are 2x4's.

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 PLAM 4145.2, Vol II/TM 38-230-2/NAVSUP PUB 503, Vol II/AFM 71-16/MCO P4030.21C

DLAM 4145.2, Vol II/TM 38-230-2/NAVSUP PUB 503, Vol II/AFP 71-16/MCO P4030.21C

Length (ft)	Members	4 ft width					6 ft width					8 ft width					10 ft width					
		Height (ft)					Height (ft) ¹					Height (ft) ¹					Height (ft)					
		4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	
6	Upper frame member	2x6	2x6				2x6	2x6	(*)			2x6	2x6	2x6			2x6	2x6	2x6			
	Lower frame member																					
	Struts	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	
8	Diagonal	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	
	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			
	Lower frame member																					
10	Struts	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	
	Diagonal	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x8	2x10	
	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			
12	Lower frame member																					
	Struts		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8	
	Diagonal	2x6	2x8	2x10	2x8	2x6	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	
16	Upper frame member	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			
	Lower frame member																					
	Struts		(**)		2x10	2x8	2x8	(**)		2x10	2x8	2x8	(**)		2x10	2x8	2x8	(**)		2x10	2x10	2x10
20	Diagonal	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x8	2x10	2x10	*2x8	2x8	2x8	2x10	2x10	2x10	
	Upper frame member	**2x8	2x8	2x6	2x6	2x6	**2x8	2x8	2x6	2x6	2x6	**2x8	2x8	2x6	2x6	2x6	*2x10	2x10	2x6	2x6	2x6	
	Lower frame member																					
24	Struts				2x8	2x8				2x8	2x8				2x6	2x8	2x10			2x6	2x10	2x10
	Diagonal	2x8	2x8	2x10	2x8	*2x8	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x10	2x10	2x10	2x8	*2x10	2x10	2x10	2x10
	Upper frame member	2x10	*2x8	2x8	2x8	2x6	2x10	**2x8	2x8	2x8	2x6		2x10	**2x8	2x8	2x8	2x8	2x10	*2x8	2x8	2x8	2x8
28	Lower frame member																					
	Struts			(**)		2x6			*2x6	2x6	2x6		2x6	*2x6	2x6	2x6		2x6	*2x6	2x6	2x6	2x6
	Diagonal	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x10
32	Upper frame member	2x12	*2x8	*2x8	2x8	2x6	2x12	*2x10	*2x8	2x8	2x6	2x12	*2x10	*2x8	2x8	2x8	2x12	*2x10	*2x8	2x8	2x8	2x8
	Lower frame member	2x6	(*)	(*)			2x12	(*)	(*)			2x8	(*)	(*)			2x8	(*)	(*)			
	Struts			(**)	2x6	2x6			2x6	2x6	2x6		2x6	*2x6	2x6	2x6		2x6	*2x6	2x6	2x6	2x6
	Diagonal	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x12	2x10	2x12	2x12

Note. All blank spaces are 2x4's.

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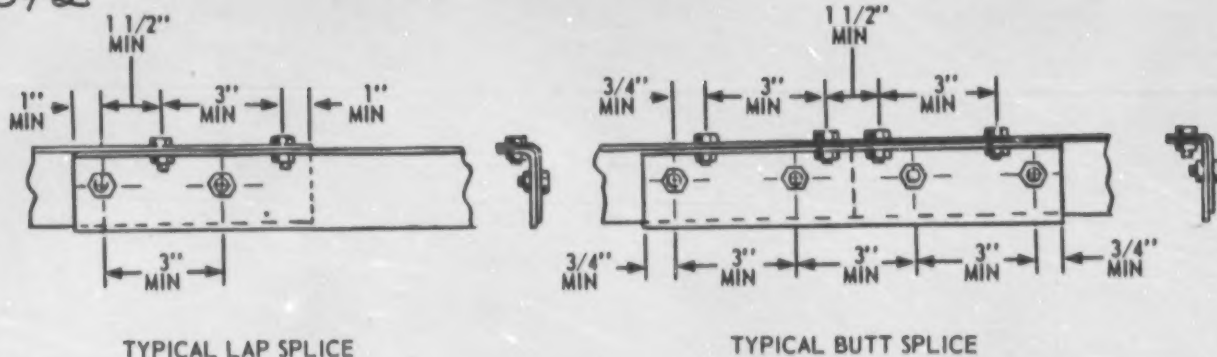


Figure 6-65. Methods of splicing.

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zinc-coated and shall conform to Specification FF-B-584 or FF-B-575.

(3) *Wood components* Skids, skid blocks, rubbing strips, load-bearing members, filler strips etc., should be made of Group II, III, or IV wood, meeting the requirements of Military Standard MIL-STD-731 and treated in accordance with TT-W-571.

(4) *Plywood.* The plywood used shall conform to Specification NN-P-530. Plywood for Grade 2 crates shall conform to PS-51, Type II, Grade 3-4 or PS-1 standard and be treated with wood preservatives in accordance with TT-W-571.

(5) *Paper-overlaid veneer.* Paper-overlaid veneer used for sheathing and covering shall conform to type II as specified in Specification PPP-V-205.

(6) *Fiberboard.* Fiberboard for sheathing and covering crates shall conform to Specification PPP-F-320, type SF class weather-resistant, grades V2s, V3s, or V4s.

(7) *Steel strapping.* Steel strapping used for either banding or tension braces should conform to type I finish B of Specification QQ-S-781.

e. Assembly.

(1) General.

(a) *Diagonal bracing.* Using slotted angle, full diagonal bracing should extend from one corner to the diagonally opposite corner, being cut on an angle on the ends to permit maximum contact of flanges. Corner braces, when used, should be placed in each corner. Diagonal and corner braces should be installed at an angle of 45° or as close to that angle as possible. A minimum of one bolt should be used at each end of a brace. Flat steel strapping, not less than 1 1/4-inch wide and 0.032 inch thick, may be used for bracing in lieu of

slotted angle steel or aluminum when it is adequate to the bracing requirements or where frame members, vertical or horizontal, side or end panel, prevent the use of the slotted angle.

(b) Joints.

1. Corner joints formed by the upper and lower horizontal crate members for the sides and ends with the vertical crate members at the ends should be bolted together as shown in figure 6-66.

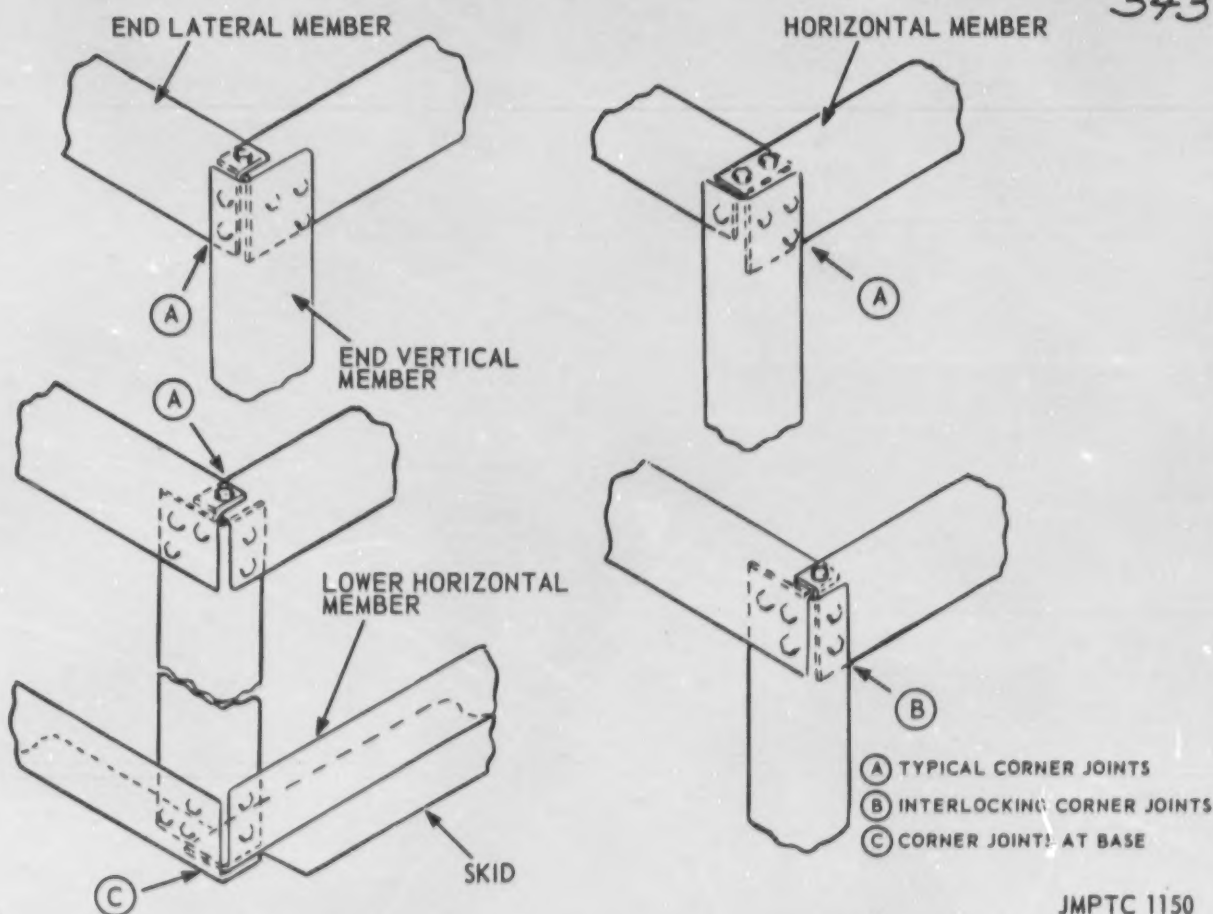
2. Intermediate vertical members (struts), upper and lower horizontal members, and upper and lower intermediate lateral members should be bolted together to effect the joints as shown in figure 6-67.

3. When additional members are added for the purpose of using shock or vibration mounts, the joints formed with other crate members should be formed by using a minimum of two bolts in the wide flange and one in the narrow flange. Short pieces of slotted angle steel or aluminum may be necessary to effect this type of joint (fig 6-67 and 6-68).

(c) *Bolting.* When bolting metal portions of the crate together consideration should be given to the maximum utilization of round holes in the metal angle. All bolts and nuts shall be drawn tight by the assembler and the nuts shall be secured against loosening by the use of lockwashers or locknuts. Self-locking nuts or serrated nuts of the type described in d(2)(a) above may be used in lieu of lockwashers or locknuts.

(d) *Sheathing.* Plywood; paper-over-laid veneer, or fiberboard may be used for sheathing of Type II crates. Figure 6-69 shows methods which may be employed in sheathing or covering crates. Figure 6-70 shows methods of attaching sheathing to slotted metal angle. Sheathing should be

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Figure 6-66. Corner joints.

fastened to a slotted angle material with not less than two bolts on each panel edge, with additional bolts being employed, if necessary, to maintain the interval between bolts at not more than 12 inches. When sheathing is attached to the top by nailing to a wooden strip which is secured to the slotted angle portion of the crate by bolts spaced not less than 24 inches apart, the nailing strip will be at least 1 by 2 inches and the nails will be at least sixpenny in size, spaced not more than 5 inches apart.

(e) *Ventilation.* Crates completely inclosed or sheathed with plywood or paper-overlaid veneer will be ventilated. Ventilation will be accomplished by means of holes or slots in the ends or ends and sides around the perimeter of the crate. They shall be placed immediately below the tip frame members of the ends and sides. When crates are over 10 feet in length, the ventilation holes or slots will be divided equally between both ends and both sides and located as near the

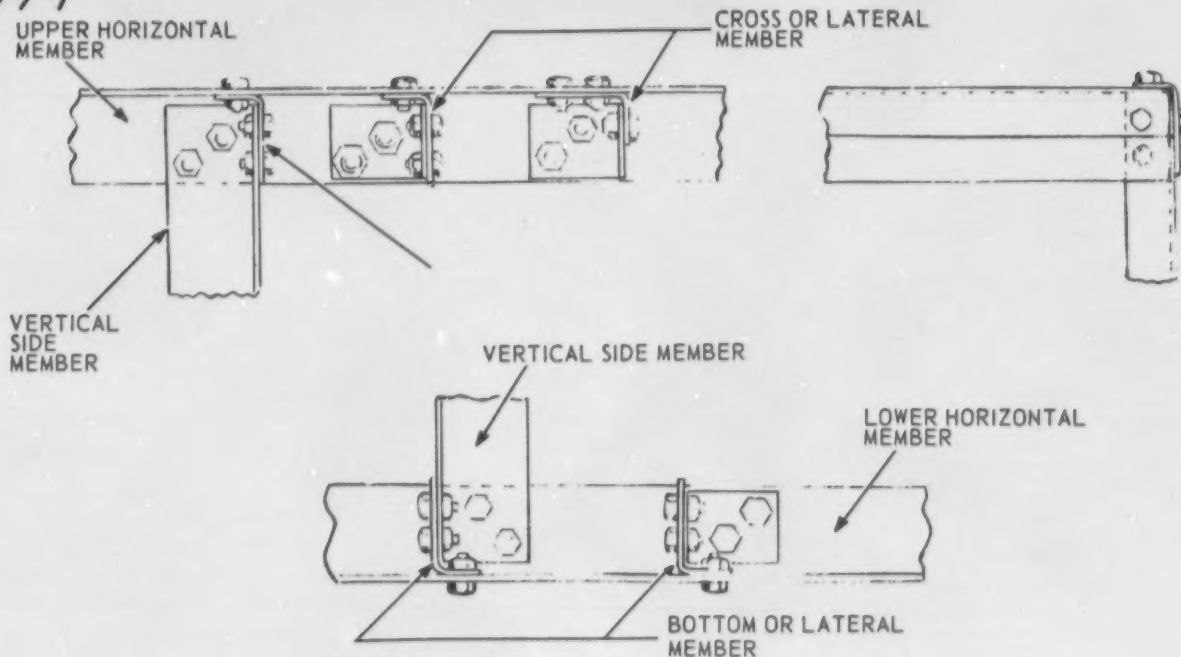
midpoint of the sides and ends as practicable. Place baffles or shields inside the crate to deflect the water blown into the crate, thus preventing the water from coming in contact with the contents. The following table establishes the area of the holes or slots required to provide ventilation for graduated range of volume for a crate (table 6-53).

(f) *Panels for marking open crates.* To provide sufficient area for placing required markings on open crates, a panel of $\frac{1}{4}$ -inch plywood will be bolted to the crate.

(2) *Specific crates.*

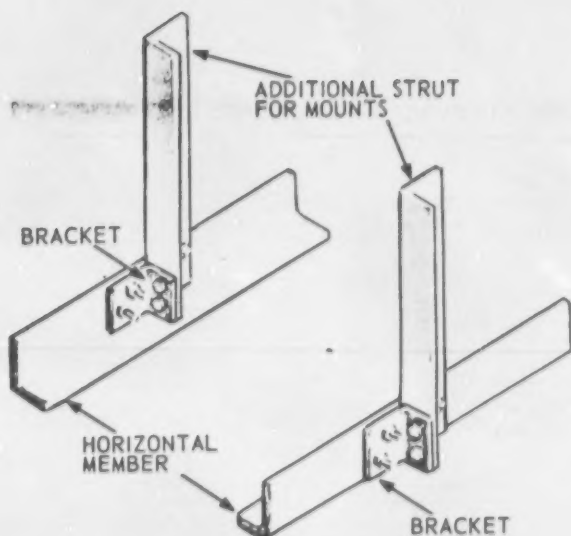
(a) *Type 1, style A.* This crate is of simple construction, usually consisting of one panel in each section, requiring minimum bracing and used for light, bulky, and small items not exceeding 200 pounds. Either the slotted angle aluminum or the smaller slotted angle steel is usually strong enough for this crate. Unless specifically

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Figure 6-67. Attachment of intermediate members.



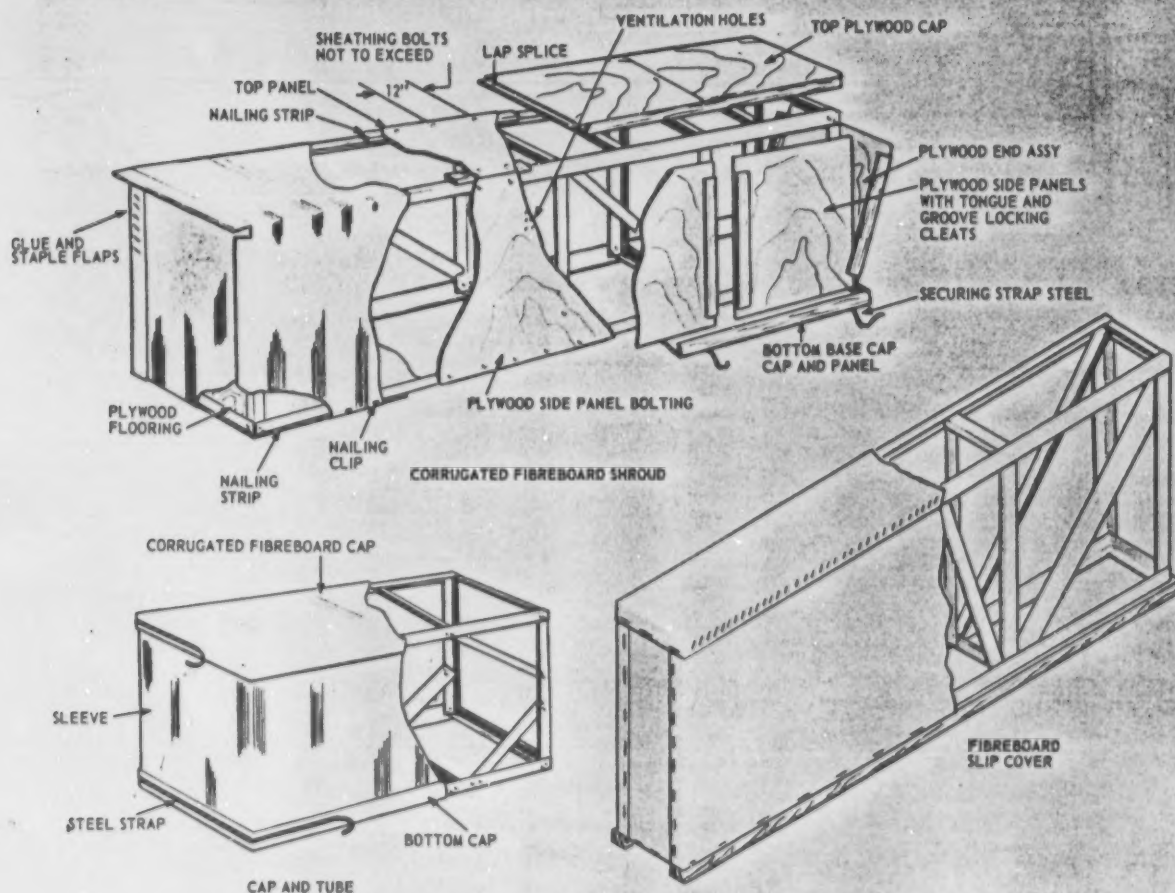
JMPTC 1152

Figure 6-68. Alternate methods of attaching members.

excepted, it is limited to maximum dimensions of 80 inches in width.

1. *Sides.* The metal angle used for the side rails (horizontal members) should be positioned with the wider flange parallel to the plane or surface of the side. The bottom rail should be positioned so that the wide flange points up, while the top rail should have the wide flange pointing down. Vertical members (struts) should be equal in length and be positioned so that they are within horizontal rails when the crate is assembled. "Vertical members should not exceed 48 inches in length and distance between vertical members (struts and intermediate struts) shall not exceed $1\frac{1}{2}$ the height of the crate. Where greater side strength or special mounting provisions are required along the side of the crate, extra vertical members may be added with the wide flange against the wide flange of the horizontal members (side rails) of the crate. Additional or intermediate vertical members should be added where the length-to-height ratio dictates."

2. *Ends.* The crate ends shall consist of slotted angle crossmembers joining the two crate sides. Additional crossmembers or intermediate struts to provide mounting or attaching points within the crate for specific items may be added to crate end as required. The distance between the



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Figure 6-59. Methods of sheathing or covering crates.

Table 6-53. Ventilation Requirements

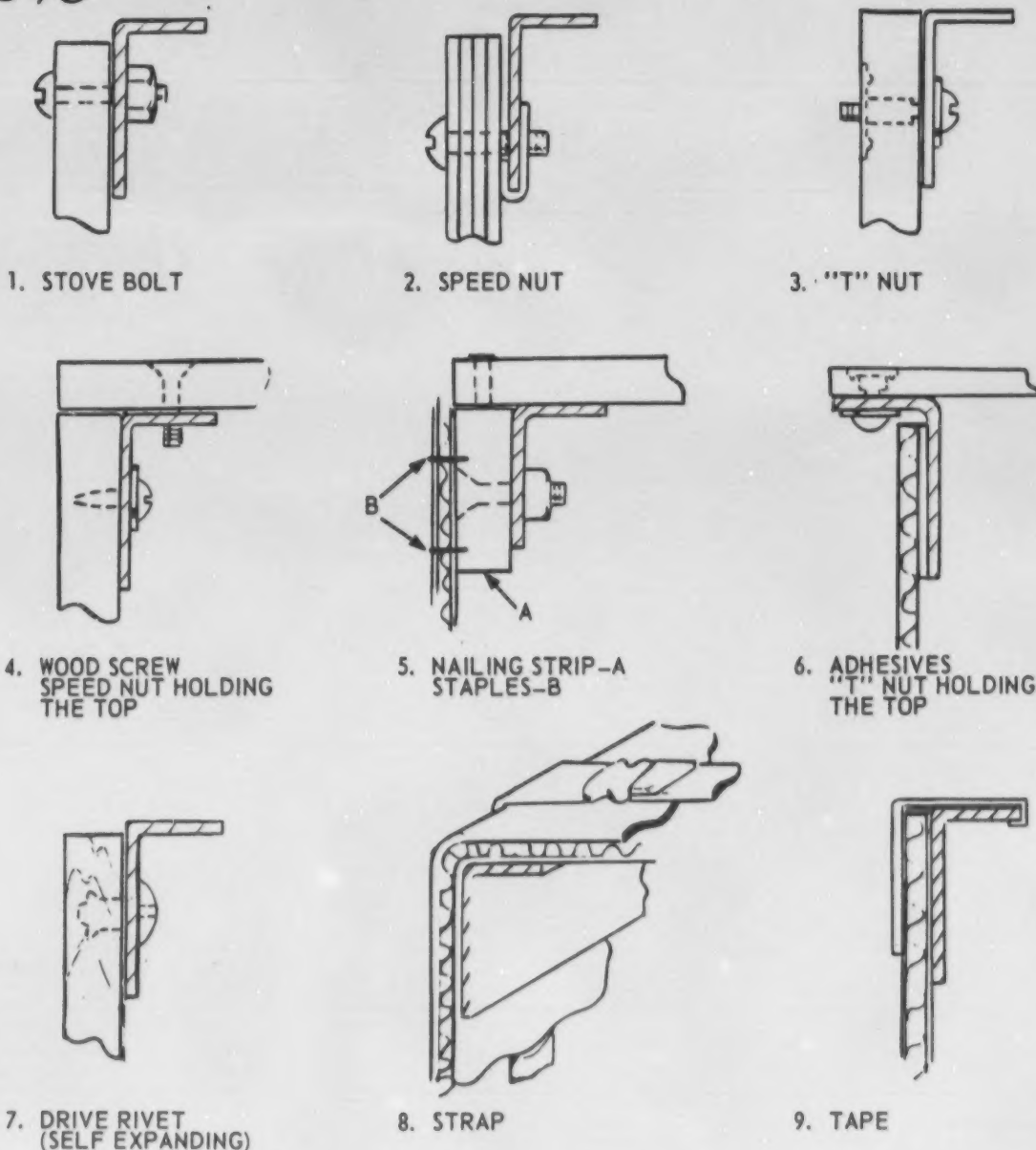
Area of holes or slots for ventilation	
Volume of crate in cubic feet	Cumulative area in square inches of ventilation holes or slots
0-100	7
101-150	10
151-200	14
201-400	27
401-600	40
601-800	52
801-1000	66
1001-1200	80
1201 and over	100

lateral members (crossmembers and intermediate struts) shall not exceed $1\frac{1}{3}$ the width of the crate.

3. *Base.* The base is not a separate panel which is bolted to the sides and ends, but is formed by the addition, as necessary, of crossmembers, (loadbearing members, flooring, and braces).

(a) *Flooring.* The crate will be sufficiently floored to protect the contained item. The flooring need not be continuous throughout the base; however, it will be placed in such locations that will provide protection to the areas of the contained item that are subject to damage by forklift trucks or other material handling equipment. Plywood flooring (except loadbearing floorboards) will be a minimum of $\frac{1}{4}$ inch thick for crates through 12 inches wide, $\frac{3}{8}$ inch for crates over 12 inches wide and through 24 inches wide, and $\frac{3}{4}$ inch thick for crates over 24 inches wide. Flooring will be cut to fit snugly in place and securely bolted to the lower side rails of the crate. Each piece of flooring shall be bolted in place with a minimum of two bolts in each lower side rail. The distance between bolts used to secure the flooring shall not exceed 12 inches. When the flooring is $\frac{3}{8}$ inch or less in thickness it is reinforced on top by an additional strip of wood 1 inch by 2 inches, through which the holddown bolt will

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Figure 6-70. Methods of attaching sheathing.

pass. Bolts used for securing floorboards shall not be less than $\frac{5}{16}$ inch in diameter.

(b) *Loadbearing members.* Loadbearing members shall be located within the crate base to carry the load of the contained item, except when suspension systems are used or when the item is attached to the side structure. The size of wood members shall be determined from table 6-54. The size of steel members shall be determined from Table 6-55.

(c) *Crossmembers.* Crossmembers will be of the same strength and quality as the slotted angle used for the side rails and struts. Crossmembers in the base will be spaced not more than 24 inches apart. If loadbearing members are employed, they should be included in the considerations for base crossmembers.

(d) *Braces.* The base should be reinforced with braces of the same slotted angle as the crossmembers. These braces should be used in

Table 6-54. Allowable Load per Inch of Floorboard Width for Groups I and II Woods

Distance between outside skids (inches)	Actual thickness of floorboards (Inches)			
	3/4	1-5/8	2-5/8	3-5/8
12	48	220	574	1,095
18	32	147	382	731
24	24	110	287	548
30	19	88	229	438
36	16	73	192	365
42	14	63	164	313
48	12	55	144	274
60	9	44	115	219
72	8	37	96	182

If group III or IV woods are used, the above allowable loads may be increased 30 percent.

unfloored areas of the crate. When one-third of the base is floored with 12-inch or wider floor panels, braces are not required.

4. *Crate top.* The top, like the base, is not a separate panel which is attached to the sides and ends. It is formed by crossmembers, crosstie members, and braces installed between the two crate sides. The crossmembers are placed perpendicular to the sides and are placed at each point where a vertical strut is bolted to the side rail, being bolted as shown in figure 6-67. The crosstie members are slotted angle members placed at intermediate points between, and parallel to, crossmembers with the distance between the crossmembers and crossties not exceeding $1\frac{1}{3}$ the width of the crate. Braces of the same type slotted angle material as that used for crossmembers are placed diagonally in the rectangle formed by the side rails and the crossmembers and crossties. The ends will be cut at an angle to give maximum contact of the flanges being bolted together.

5. *Use of corner braces for light crates.* Where crates are intended for net loads not in excess of 200 pounds and limited to the maximum dimensions of 60 inches in length, 30 inches in width, and 48 inches in height, corner bracing may be utilized in lieu of full diagonal bracing.

(a) *Type II, Style A crate.* This crate is identical to the Type I, Style A crate, except that it is fully closed or sheathed using plywood, paper-overlaid veneer, or fiberboard, as specified in d(4), (5), and (6) above. Sheathing should be added in accordance with provisions of e(1)(d) above.

(b) *Type I, Style B crate.* The Style B (skidded) crate is intended for use in crating larger and/or heavier items, employing a skidded base; braced sides, ends and top; loadbearing and attaching members; and provisions for truck and

cargo sling handling. Only slotted angle steel (not aluminum) will be used in fabricating this style crate. Unless specific approval is given for a larger size crate, the maximum dimensions are 360 inches in height (see fig 6-71 for a typical crate).

1. *Sides.* Crate sides consist of horizontal members (side rails), vertical members (struts), and full diagonal braces.

(a) *Intermediate horizontal members.* When a crate exceeds 48 inches in height, an intermediate horizontal member should be placed between the top and bottom side rails and should run the full length of the crate. In addition to the requirement for additional intermediate horizontal members because of the height, extra strength requirements may demand additional horizontal members.

(b) *Intermediate vertical struts.* Intermediate struts shall be evenly and systematically spaced throughout the length of the crate side between the end or corner vertical struts. The spacing of intermediate struts for crates with sides not provided with an intermediate horizontal member shall be determined by the height and length. The distance between the vertical struts shall not exceed $1\frac{1}{4}$ the height of the crate. The spacing of intermediate struts for crates with sides provided with intermediate horizontal members shall be determined by the same method as above, except that the height shall be considered as the distance between the two adjacent horizontal members.

2. *Ends.* The ends are not assembled panels which are bolted to the sides but are formed by the upper and lower crossmembers, intermediate crossmembers, and braces which join the sides. In addition to the upper and lower crossmembers, intermediate crossmembers are required when the height of the crate exceeds 48 inches or when the height of the crate exceeds $1\frac{1}{4}$ width of the crate. The maximum interval between any two adjacent crossmembers is 48 inches. Intermediate crossmembers shall be installed with the wider flange of the angle in a vertical position. Intermediate vertical members may be added to the ends for special mountings and special blocking and bracing. Bracing of the ends may be done either with slotted angle material equal to that used for side bracing or with flat steel strapping (as in e(1)(a) above). When a crate is in excess of 60 inches long, 18 inches wide, or subject to being pushed by forklift trucks or other equipment, it should be equipped with push plates to protect the crate and contents (fig 6-72). The push plates are positioned across the lower part of

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Table 6-55. Load Table For Slotted Angle.

SLOTTED ANGLE (STEEL) 14 GAUGE (.074) 1-1/2" x 1-1/2"
VERTICAL SUPPORTING SECTIONS

(Length of Column in Feet - Load in Pounds)					
		3'	4'	5'	6'
Recommended Load		1480	1180	940	742
Recommended Load		3830	3475	2970	2475
Recommended Load		3900	3565	3170	2620

SLOTTED ANGLE (STEEL) 14 GAUGE (.074) 1-1/2" x 2-1/4"
VERTICAL SUPPORTING SECTIONS

(Length of Column in Feet - Load in Pounds)						
		3'	4'	5'	6'	7'
Recommended Load		2490	1850	1530	1280	940
Recommended Load		5500	5000	4350	3800	3350
Recommended Load		5600	5390	5000	4480	4150

SLOTTED ANGLE (STEEL) 12 GAUGE (.104) 1-1/2" x 3"
VERTICAL SUPPORTING SECTIONS

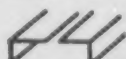
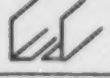
(Length of Column in Feet - Load in Pounds)						
		3'	4'	5'	6'	7'
Recommended Load		3450	2870	2360	1670	1150
Recommended Load		7960	7040	6240	5400	4500
Recommended Load		8900	7940	6700	5800	4650

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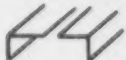
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Table 6-55. (Cont.) Load Table For Slotted Angle.

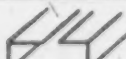
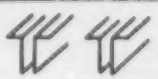
SLOTTED ANGLE (STEEL) 12 GAUGE (.104) 1-1/2" x 3"

		(Length of Beam in Feet - Load in Pounds)				
		2'	3'	4'	5'	6'
Recommended Load		1450	980	740	500	350
Recommended Load		4500	3100	2100	1200	1000
Recommended Load		10400	7500	5300	4350	3500
Recommended Load		1550	1000	760	580	490

SLOTTED ANGLE (STEEL) 14 GAUGE 1-1/2" x 2-1/4"

		(Length of Beam in Feet - Load in Pounds)				
		2'	3'	4'	5'	6'
Recommended Load		1260	850	610	400	200
Recommended Load		2400	1700	1150	820	625
Recommended Load		5190	3350	2700	2100	1700
Recommended Load		800	510	390	300	250

SLOTTED ANGEL (STEEL) 14 GAUGE 1-1/2" x 1-1/2"

		(Length of Beam in Feet - Load in Pounds)			
		3'	4'	5'	6'
Recommended Load		495	270	190	145
Recommended Load		590	395	297	190
Recommended Load		1335	1035	693	540

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Table 6-55. (Cont.) Load Table For Slotted Angle.

SLOTTED ANGLE (ALUM) 13 GAUGE (.089) 1-1/2" x 2-1/4"

		(Length of Beam in Feet - Load in Pounds)			
		3'	4'	5'	6'
Recommended Load		450	350	260	180
Recommended Load		950	600	*400	*350
Recommended Load		2200	1600	1240	940
Recommended Load					

*On spans of this length, cross baring gives a better structure, higher recommended load.

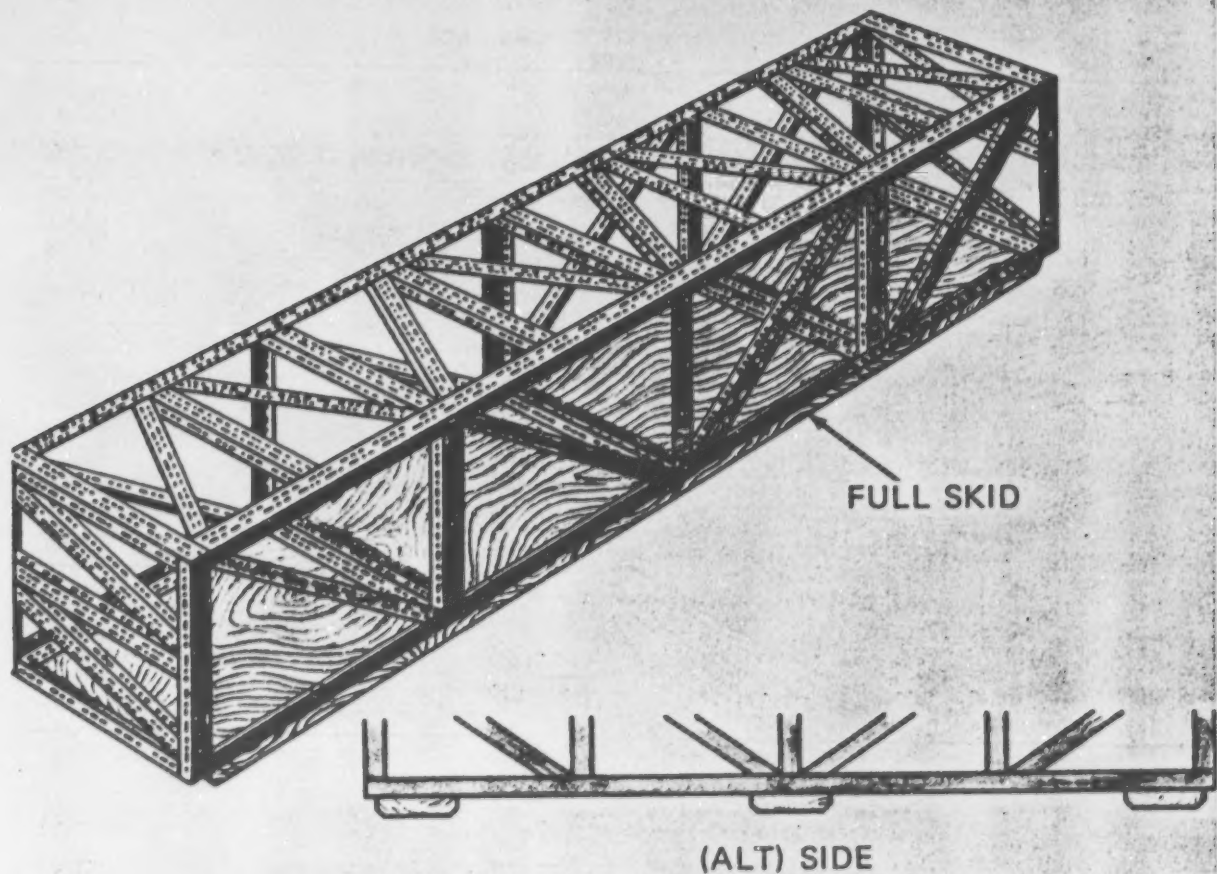
SLOTTED ANGLE (ALUM) 13 GAUGE 1-1/2" x 2-1/4"
VERTICAL SUPPORTING SECTIONS

		(Length of Column in Feet - Load in Pounds)				
		3'	4'	5'	6'	7'
Recommended Load		1000	900	700	600	
Recommended Load		3100	2730	2430	2170	1750
Recommended Load		3500	3100	2700	2400	2100

the end panel with the lower part of plate flush with top of the skids and shall be bolted to the corner struts with a minimum of two bolts in each end of the plate. Group II, III, or IV wood or plywood may be used for crates having a gross weight up to 500 pounds. They shall be Group III or IV wood when the gross weight exceeds 500 pounds. They shall be Group III or IV wood when the gross weight exceeds 500 pounds. When push plates are made from wood they shall be a minimum 1 3/8 inches thick and 7 1/2 inches wide. Plywood push plates shall be a minimum 3/4 inch thick and 12 inches wide.

3. Top. The top, like the ends, is formed by joining the two sides together, through the use of crossmembers, crossties, and braces of slotted angle material. The end crossmembers serve also as the top crossmembers of the ends. Additional crossmembers are bolted as shown in figure 6-67, the wider flange being vertical and the narrow flange at the top. When the distance between the crossmembers is greater than 1 1/4 times the width of the crate, intermediate crossmembers (crossties) should be used, placing them equidistant between the crossmembers. Sufficient crossties should be used to maintain an interval not in

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Figure 6-71. Type 1, Style B crate.

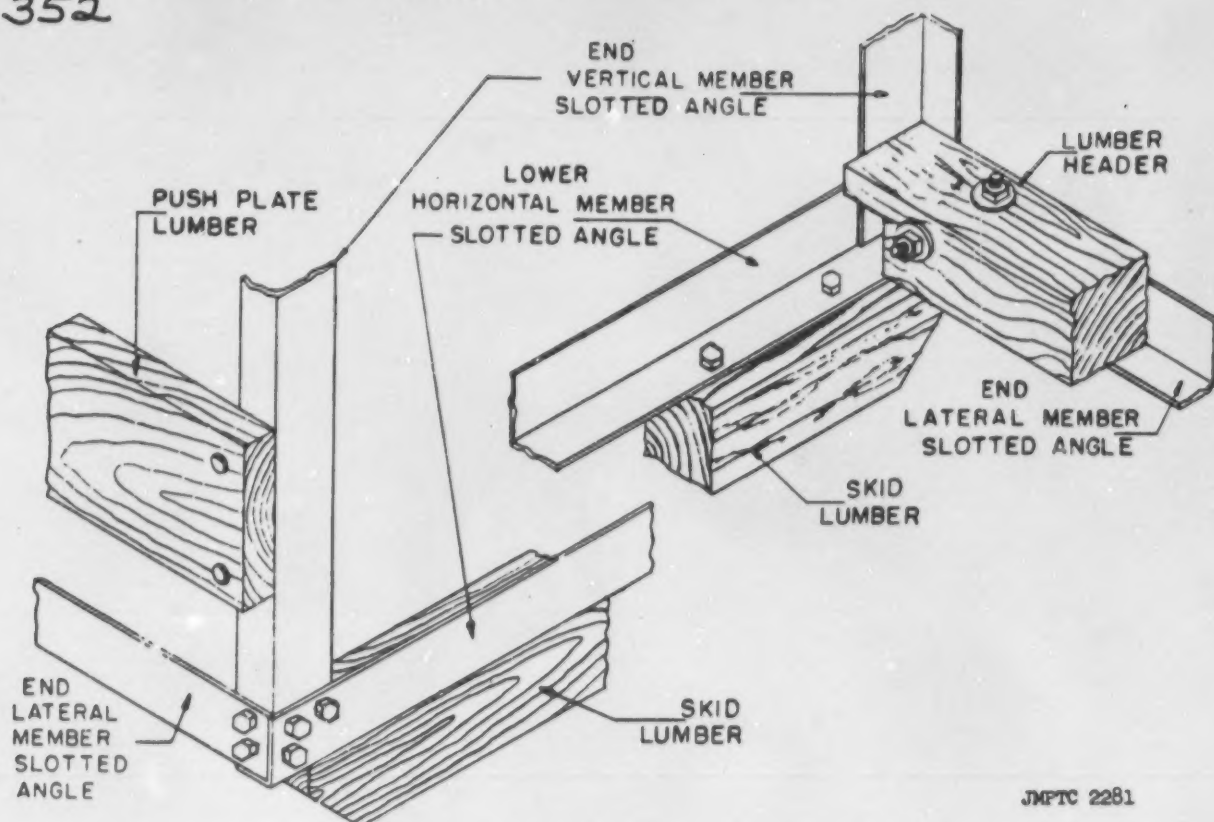
excess of $1\frac{1}{4}$ times the width of the crate between any two adjacent crossmembers and/or crossties. (See fig 6-67 for the bolting pattern.) Full diagonal braces should be used in the interval between adjacent crossmembers and/or crossties. Tension braces of steel strapping may be used in lieu of slotted angle material (e(1)(a) above).

4. *Base.* Crossmembers and crossties tying the side panels together at the bottom of the crate plus required loadbearing members, forklift truck handling members, skid blocks, full skids, headers, and flooring comprise the base.

(a) *Skid blocks and full skids.* When the load contained by the crate exceeds 500 pounds, full skids running the length of the crate shall be used. Full length skids may be used for lesser contained weights, but are not mandatory. Full length skids shall be fabricated from minimum nominal 2 x 4-inch lumber for net loads up to 1,000

pounds and 4 x 4-inch lumber for net loads exceeding 1,000 pounds. They shall be provided with 2 x 4-inch rubbing strips. When full length skids are not used, 2 x 4-inch skid blocks 16 inches long are used. Skids and skid blocks shall be beveled 45 degrees on each end. Skid blocks located at the ends of the crate shall be set $2\frac{1}{2}$ to 4 inches from each crate end to permit the use of slings. Rubbing strips on full length skids shall be set back an equal distance from each crate end. Intermediate skid blocks shall be placed in locations that will support loads transferred to the lower side rails by loadbearing members and struts. The center of balance of the loaded crate shall be the determining factor in locating intermediate skid blocks to provide the forklift entry. The maximum distance between skid blocks shall not exceed 48 inches. Skid blocks, skids, and rubbing strips shall be bolted to the lower side rails with minimum $\frac{5}{16}$ -inch diameter bolts (fig 6-72).

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Figure 6-72. Method of attaching push plates, skids, and headers.

(b) *Loadbearing members.* To provide direct support to loads resting on the base, loadbearing members are used. These members may be either wood, plywood, metal, or a combination of wood and metal and are placed at right angles to the length of the crate, being bolted to both of the lower side members. See tables 6-54 and 6-55 for tabulated data to be used in determining the size, etc., of material for loadbearing members.

(c) *Flooring.* Flooring may be lumber or plywood and need not be continuous throughout the base; however, it shall be placed in such locations as will provide protection to the areas of the contained item that is subject to damage by forklift trucks or other material handling equipment. The flooring should be cut to fit snugly in place and should be bolted to both of the lower side each end of each piece of flooring with a minimum of two bolts to a rail. Plywood flooring shall have a minimum thickness of $\frac{3}{8}$ inch for crates through 12 inches wide, $\frac{1}{2}$ inch for crates 12 to 24 inches wide, and $\frac{3}{4}$ inch for crates over 24 inches wide. Lumber flooring shall have a minimum thickness of $\frac{3}{4}$ inch.

(d) *Forklift truck handling members.*

Forklift truck handling members of lumber or metal, the size of which is based on strength required as applied to the data shown in tables 6-54 and 6-55, will be placed 24 inches from each end of the crate and at right angles to the length, being bolted to both of the lower side rails. When the crate is in excess of 36 inches in width, forklift truck handling members should be placed at the location provided for side entry of forklifts and, if the crate is over 8 feet in length, they should be in addition to those placed 24 inches from the end. Loadbearing members, if suitably located, may serve as forklift truck handling members.

(e) *Type II, Style B crate.* Except for the sheathing, this crate is fabricated in the same manner as the Type I, Style B crate. The sheathing is accomplished in the manner described in (1)(d) above.

(6) *Crossties and headers.* When the distance between loadbearing members exceeds the width of the crate and the flooring is less than $\frac{3}{4}$ inch thick, intermediate crossties should be installed, being bolted to both of the flanges of both lower side rails (fig 6-67).

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CHAPTER 7

CONSOLIDATION AND UNITIZATION FOR SHIPMENT AND USE OF CARGO CONTAINERS

7-1. Consolidation and Unitization for Shipment

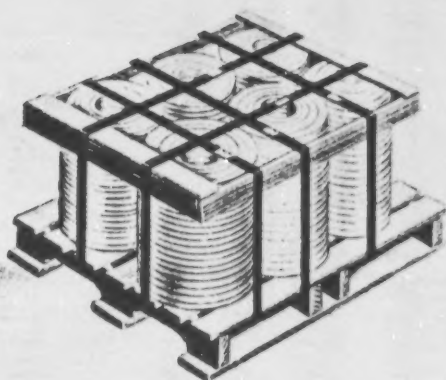
Consolidation is the bringing together of like or unlike items for shipment. Once the items are assembled, they must be kept together as a single unit until they reach a break-bulk point or the ultimate consignee. Unitization results in econ-

omy through reduction in handling and documentation, one unit taking the place of several units.

a. Advantages. Figure 7-1 gives advantages of unitizing loads which are as follows:

(1) Eliminates laborious and expensive manual handling of individual items.

ADVANTAGES OF CARGO UNITIZATION LOADS



PALLETIZED LOAD

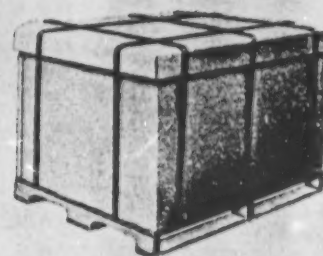
ECONOMY

GREATER SPEED IN
HANDLINGDECREASED DAMAGE
TO MATERIAL

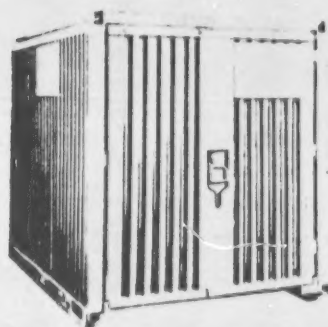
SAFETY

LESS CHANCE FOR
PILFERAGEPROTECTS AGAINST
ENVIRONMENTAL
CONDITIONS

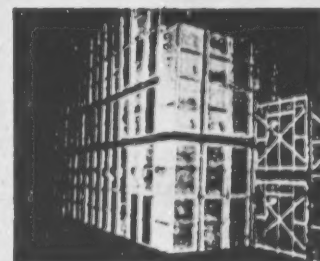
UTILIZATION OF SPACE



TRIPLE-WALL FIBERBOARD



CARGO TRANSPORTER



WAREHOUSE STORAGE

JSTC 1320

Figure 7-1. Advantages of cargo unitization.

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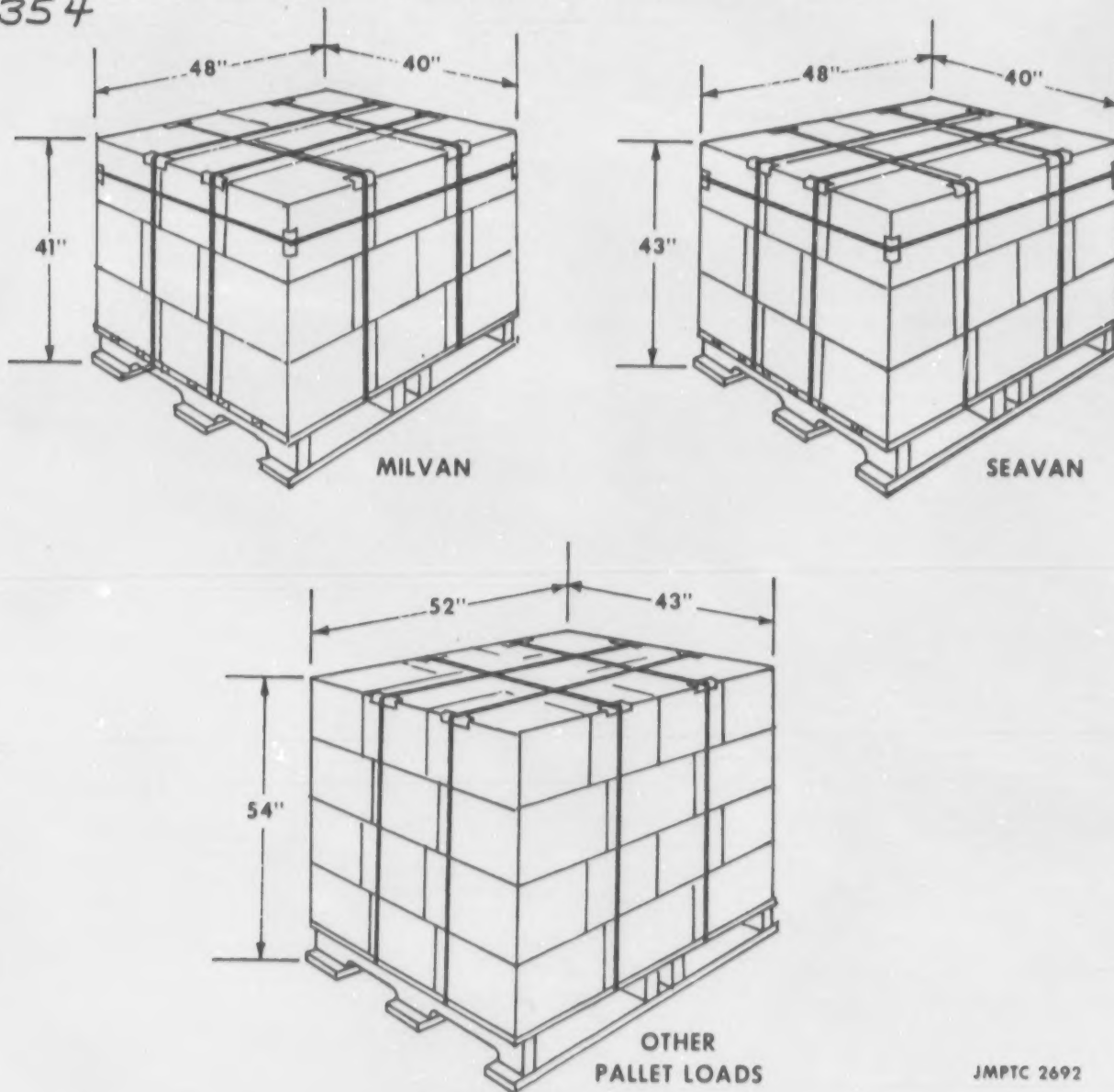


Figure 7-2. Pallet size limitations.

- (2) Reduces damage to items by eliminating manual handling.
- (3) Permits savings in handling costs.
- (4) Reduces personnel accidents by eliminating manual handling and lifting.
- (5) Simplifies inventorying and reduces inaccuracies.
- (6) Utilizes storage heights not possible by manual means.
- (7) Reduces pilferage because of unitization of items by steel straps and other bonding methods.

- (8) Permits faster movement of supplies and equipment and provides greater utilization of carrier equipment.
- (9) Reduces marking requirements on individual containers.

b. Forms of Unitization. The two basic forms of unitization are—

- (1) *Palletization.* This is the placing of a number of packages on a low, portable platform of wood, metal, or fiberboard, or a combination of these materials.

(2) *Containerization.* This is the placing of a number of packages into a container, which not only reduces the number of units and documentation, but provides additional protection to the packages.

7-2. Palletizing Unit Loads (MIL-STD-147)

Military Standard MIL-STD-147 gives the palletized unit load requirements for Department of Defense material using the pallets discussed in paragraphs 3-10 and 3-11. The standard establishes loading patterns for various types of commodities, listing the pattern for stacking containers and the methods of unitizing to be used.

a. Limitations. The following size and weight limitations apply to the complete load including the pallet and the bonding and storage aids (fig 7-2).

(1) Unless otherwise specified by the procuring activity, load units prepared for shipment in MILVANS and SEAVANS shall not exceed 40 inches in length. All other loads shall not exceed 43 inches in length, which permits an overhang of 1½ inches at each end of the pallet.

(2) Unless otherwise specified by the procuring activity, load units prepared for shipment in MILVANS and SEAVANS shall not exceed 48 inches in width. All other loads shall not exceed 52 inches in width, which permits an overhang of 2 inches at each side of the pallet.

(3) Load units prepared for shipment in containerization media such as SEAVANS, etc. shall not exceed 43 inches in height and in MILVANS, 41 inches. All other loads shall not exceed 54 inches in height, except as permitted for loads of compressed gases in cylinders.

(4) The maximum gross weight of a load shall not exceed 3,000 pounds per single pallet load for domestic, intercoastal, or oversea shipments.

b. Types of Palletized Loads. Types of supplies that can be palletized are

(1) Items which are identical and identified by the same stock number.

(2) Items uneconomical or impractical to pack otherwise.

(3) Rugged and durable items that require minimum physical protection.

(4) Boxed items uniform in size requiring additional protection.

(5) Items that are moved in large quantities.

c. Load Arrangement. The arrangement of items to the pallet must provide a rigid, compact, uni-

form size load, strongly secured to prevent shifting, and capable of resisting impact, vibration, racking, and compression encountered during handling, storage, and shipment. Basic principles for arranging and securing loads to pallets are—

(1) Items should be interlocked, nested, or bundled whenever possible.

(2) The load pattern should eliminate or reduce void space.

(3) Wood separators or spacers are placed in voids between rows and layers of irregular-shaped items to insure a firm and stable load.

(4) The top surface of the loading pallet must be level, or made level for stacking purposes. This can be accomplished by applying a wood top frame or leveling boards with a supporting framework.

(5) Loads difficult to stabilize or which are compressible and not sufficiently firm to support superimposed loads, will be reinforced with a supporting framework as prescribed in (4) above.

(6) Boxed items are arranged on the pallet so that the markings on individual containers do not show on two adjacent sides of the palletized load. This will provide clear areas for unit load marking.

(7) The load is secured to the pallet, using the applicable size of strapping given in table 7-1 for applying lengthwise and crosswise strapping. Horizontal strapping is the same size as the tie-down strap size. The gross weight of the load, divided by the total number of tie-down straps to be used, determines the weight which must be borne by each strap. This weight is compared with the strap capacity listed in table 7-1. The strapping which has the same or next higher capacity is used. Non-metallic strapping is not authorized for the strapping of palletized loads of wooden, plywood, or metal shipping containers.

(8) Strapping is applied in a manner that will eliminate any possibility of slippage. Wood cleats, tie blocks, or braces are used under straps when necessary to insure stability or to bridge unsupported spans.

d. Loading. To properly load a pallet, consideration must be given to the type of item, its weight, and destination. It is recommended that Military Standard MIL-STD-147 be followed when loading 40- x 48-inch pallets. Figure 7-3 illustrates one common type of palletized load out of the many types illustrated in the standard.

7-3. Shrink Film Palletization

Plastic films such as polyethylene are now being used in accordance with the requirements of

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Table 7-1. Maximum Safe Working Capacities of Steel and Nonmetallic Strapping (para 7-2c(7))
Metal Strapping QQ-S-781

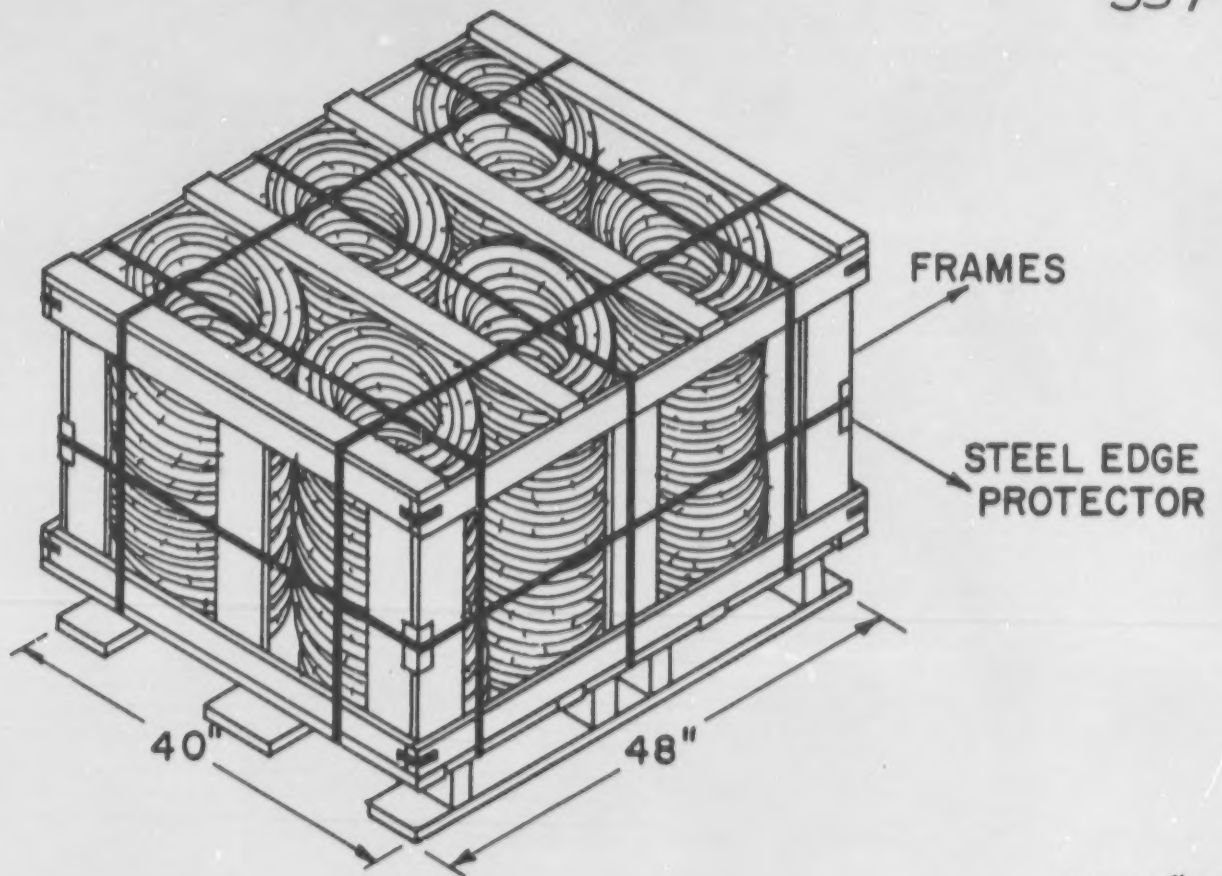
Flat Strapping			Round Strapping	
Nominal width and thickness Inch Size	Standard (Cold rolled)	High Tension Hot rolled (HR) Cold rolled (CR)	Wire Size	Safe Capacity Maximum per strand
(inches)	(pounds)	(pounds)	(gage)	(pounds)
3/8 x 0.015	112			
3/8 x 0.020	150			
3/8 x 0.23	150			
1/2 x 0.15	150			
1/2 x .020	200		16	107
5/8 x .020	250		15	140
5/8 x .023	300		14	175
3/4 x .023	350		13-1/2	200
3/4 x .025		575 (CR)	13	230
3/4 x .028	450	575 (HR)	12-1/2	265
3/4 x .031		725 (CR)	12	300
3/4 x .035	525	725 (HR)	11	375
1-1/4 x .031		900 (CR)	10	500
1-1/4 x .035		900 (HR)	9	600
1-1/4 x .044		1275 (CR)	8	720
1-1/4 x .050		1275 (HR)		
1-1/4 x .065		1700 (HR)		
2 x .044		2000 (CR)		
2 x .050		2000 (HR)		
2 x .065	2625 (HR)			

Nonmetallic Strapping PPP-S-760
Type II

Nominal width and thickness	
Inch Size	Safe Capacity Maximum per strap
(inches)	(pounds)
1/4 x 0.015	75
1/4 x .020	100
1/4 x .025	125
3/8 x .015	112
3/8 x .020	150
1/2 x .0125	120
1/2 x .015	150
1/2 x .020	200
1/2 x .025	250
1/2 x .030	300
5/8 x .015	190
5/8 x .020	250
5/8 x .025	310
5/8 x .030	375
1-1/4 x .035	900

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Figure 7-3. Example of palletized load.

MIL-STD-147 as a means of bonding palletized loads. The plastic film is stretched in the manufacturing process; this is called "orientation." The stretched film shrinks when subjected to a controlled flow of heated air. The heated air is supplied by the use of a heat shrink cannon (fig 7-4) or a shrink film chamber (fig 7-5). The heat causes the film to shrink, conforming to the contour of the load. For this reason, it can be used for pallet loads containing a variety of items which form irregular shaped configurations that could not be palletized by conventional means. The tightly adhering film immobilizes the contents and provides stability. It also provides some weather protection for exposed cargo. Shrink film palletization provides a reduction of labor and material cost by the use of automatic equipment and eliminates the problem of damage caused by too tight strapping of containers.

7-4. Consolidation Containers (General)

Consolidation containers may be constructed of fiberboard, paper-overlaid veneer, plywood, or lumber. They may be demountable or non-demountable. They are usually secured to a pallet base or a skid base for handling purposes. Some containers are intended to be expendable, while others are intended to be reusable. Some consolidation containers are designed to be compatible with the requirements of the 463L Materials Handling System of the Air Force. Others are designed to be used as inserts in transporters such as CONEXES, MILVANS, or SEAVANS, or to be used as separate shipping containers.

7-5. Expendable Fiberboard Pallet Boxes (MIL-P-26342)

Military Specification MIL-P-26342 covers the re-

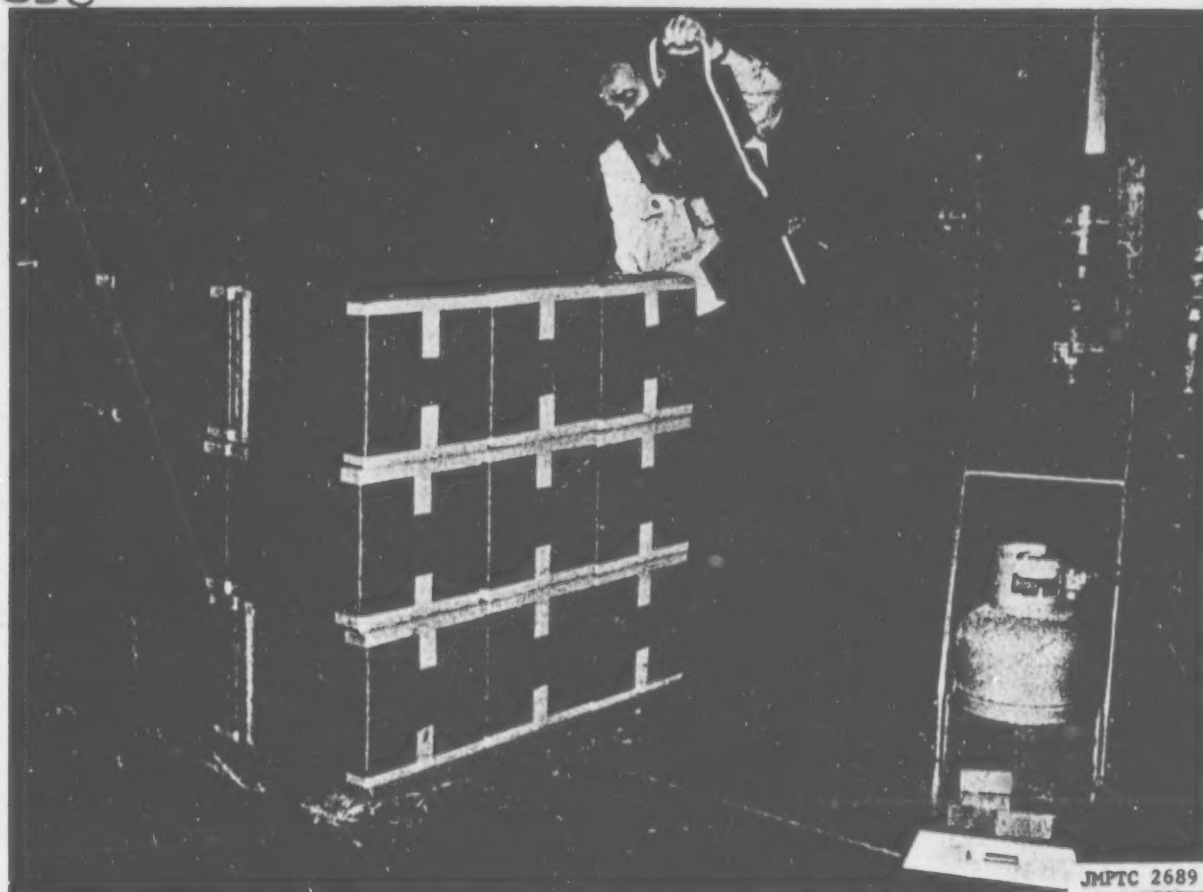


Figure 7-6. Use of cannon to heat shrink film around palletized load.

quirements for fabricating two classes of expendable fiberboard pallet boxes (fig 7-6).

a. Classification. These containers are classified as either domestic or weather-resistant.

b. Description. These containers are fabricated from fiberboard and consist of a pallet base, bottom tray with drainage holes, body, and top cap. The weather-resistant class of boxes has an auxiliary tray which fits inside and at the bottom of the box. This auxiliary tray may be specified for the domestic class also, when necessary. An interlocking top cap (fig 2-9) may be specified for either class of box, when necessary. Dividing inserts may also be specified for either class of box. Table 7-2 lists the size designations and applicable dimensions together with the weight capacities applicable to each size box. See table 7-3 for the number of inserts required for each size box.

c. Closure and Strapping Requirements.

(1) After the boxes are packed and closed, they are strapped with nailless flat steel strapping with formed edges conforming to Specification QQ-S-781. The minimum size should be $\frac{3}{4}$ x 0.015 inches with a minimum tensile strength of 80,000 psi.

Table 7-2. Size Designations, Dimensions, and Load Limitations (MIL-P-26342)

Size designation	Dimensions (inches)			Maximum load (lb)
	Length	Width	Depth	
A1	35	35	12	500
A2	35	35	24	500
A3	35	35	36	500
B1	40	48	12	800
B2	40	48	24	800
B3	40	48	36	800

Table 7-3. Number of Dividing Inserts Required for Each Size Designation of Expendable Fiberboard Pallet Box (MIL-P-26342)

Size designation	Length of insert (inches)		
	36	40	48
A1	5		
A3	10		
A3	15		
B1		3	2
B2		6	4
B3		9	6

Note 1. An insert is the single sheet of fiberboard cut to the interior dimension of either the width or length of the box, and notched to permit matching with other inserts running in a perpendicular direction.

Note 2. The lengths 36", 40", and 48" indicate the outside dimension of the box in which the insert is to be used, modified to allow for the thickness of the fiberboard utilized in manufacturing the box.

(2) Two girthwise straps shall be applied to sizes A-1, A-2, and A-3. The straps shall be perpendicular to each other on the top and bottom and placed approximately $\frac{1}{2}$ -inch from one edge of the center row of posts (fig 7-7).

(3) Three girthwise straps shall be applied to sizes B-1, B-2, and B-3. Two straps shall go around the top, sides, and bottom at the center of the forklift finger areas and one strap shall go around the top, ends, and bottom. This one strap shall be placed approximately $\frac{1}{2}$ inch from one edge of the center row of post (fig 7-7).

(4) Straps shall be applied straight and sufficiently tensioned to imbed into the edges of the pallet box, but not to the extent of cutting, tear-

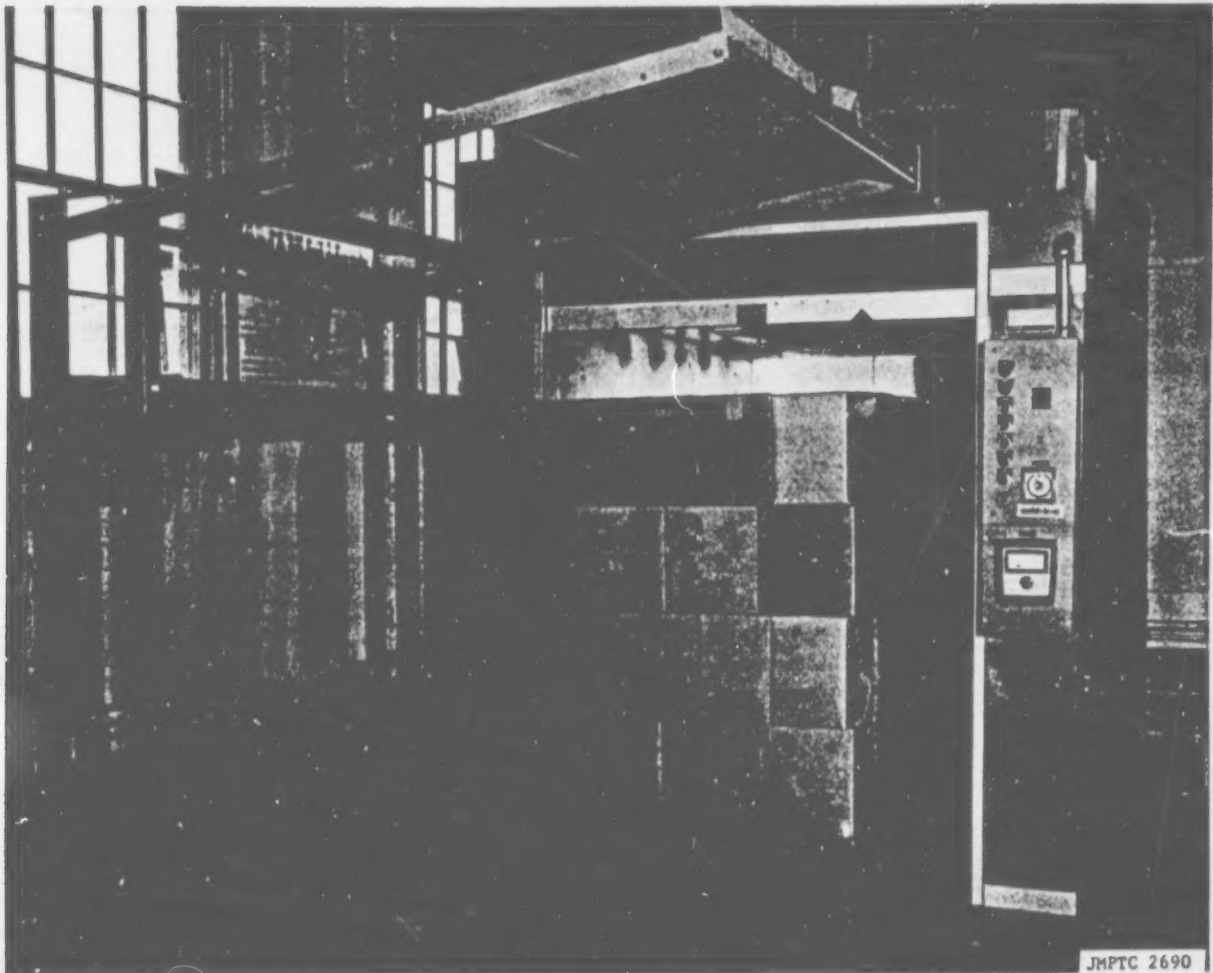


Figure 7-5. Shrink film chamber used for heat shrinking film around palletized load.

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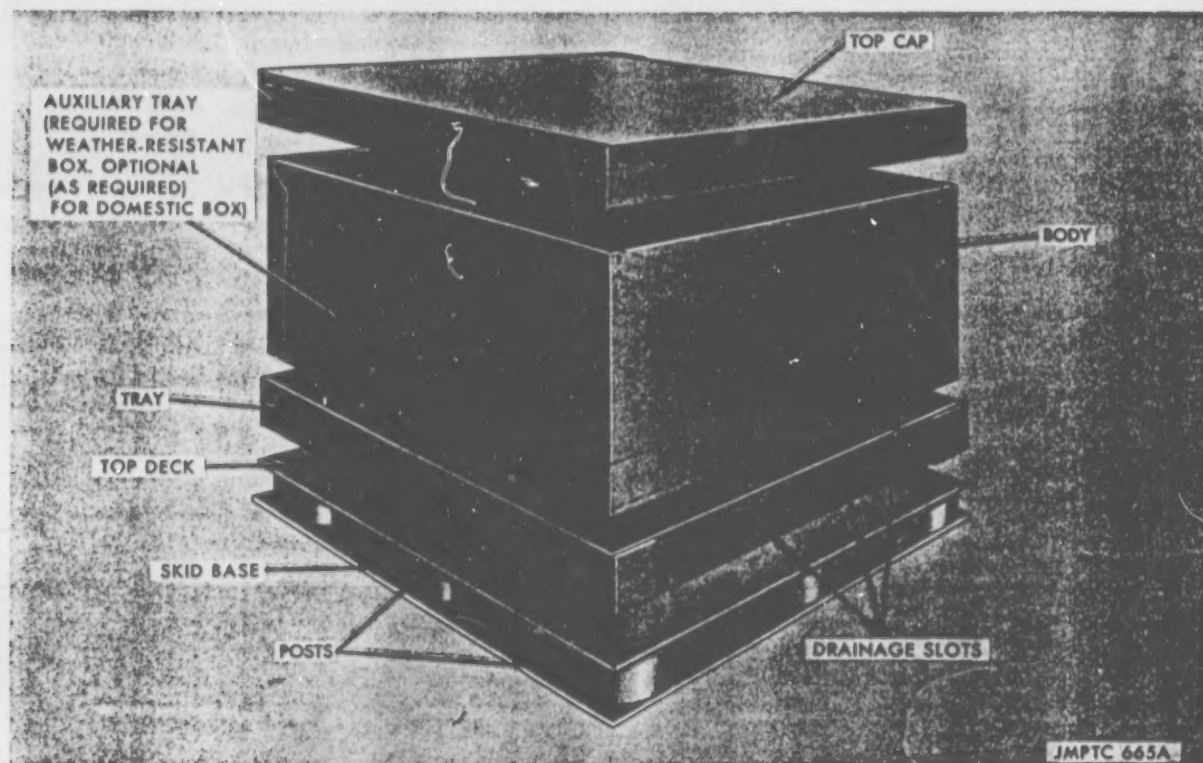


Figure 7-6. Expendable fiberboard pallet box (MIL-P-26342).

ing, or otherwise damaging the fiberboard or crushing the contents. Exposed ends of strapping shall not be of a hazardous length.

7-6. Fiberboard Consolidation Containers (MIL-B-38721) (USAF)

Military Specification MIL-B-38721 (USAF) covers fabrication requirements for weather-resistant, high stacking strength, double-wall and triple-wall corrugated fiberboard boxes (fig 7-8).

a. Selection and Use. These boxes are intended for domestic and overseas consolidation shipments of aircraft parts and general supplies and equipment. They were designed as a standard system of fiberboard containers to meet the requirements of the 463L Materials-Handling Support System of the United States Air Force.

b. Classification. These containers have been classified into two types and two styles (fig 7-8).

Type I. Double-wall corrugated fiberboard

Type II. Triple-wall corrugated fiberboard

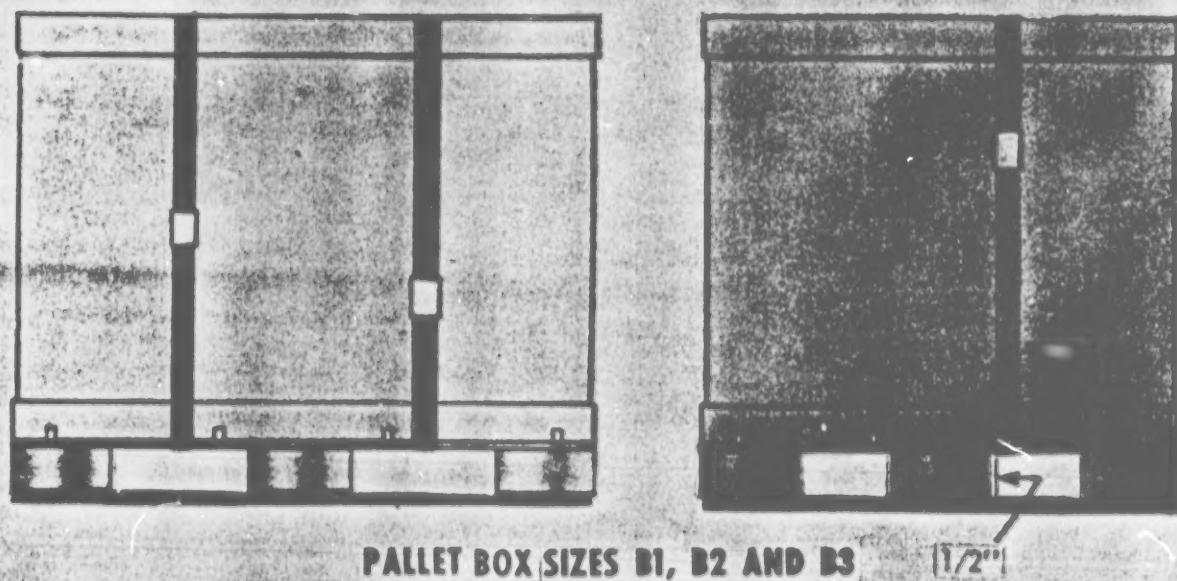
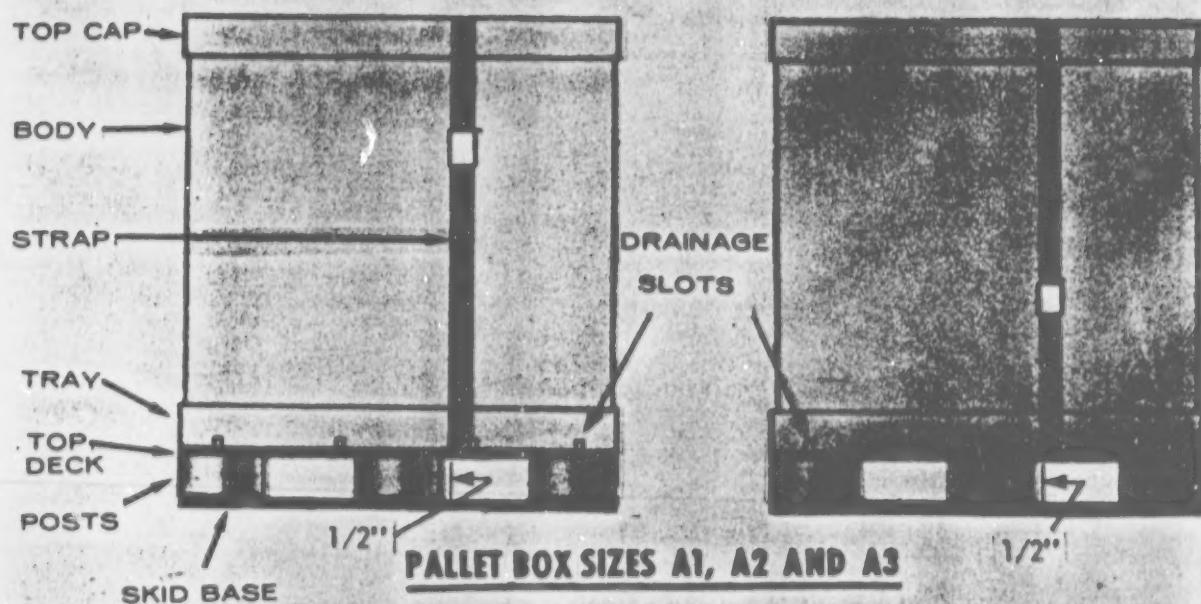
Style S. A three-piece box consisting of a sleeve (tube body) with top and bottom covers

Style T. A two-piece box consisting of a half-slotted container body with a cover

c. Size Limitations. The size designations, together with the types and styles to which they pertain, and the dimensions of the boxes are included in table 7-4.

Table 7-4. Fiberboard consolidation box sizes (MIL-B-38721)

Size designation	Applicable to		Inside dimensions (inches)		
	Type	Style	L	W	D
Sixteenth -----	I	S	23	x 18-1/3	x 15
Eighth -----	I	S	23	x 18-1/2	x 29
	II	S	22-1/2	x 18	x 28-1/2
Quarter -----	I	S	40	x 23	x 29
	II	S	39-1/2	x 22	x 28-1/2
Half -----	II	S&T	47-1/2	x 22-1/2	x 28
Full -----	II	T	83	x 39-1/2	x 28
				x 49	

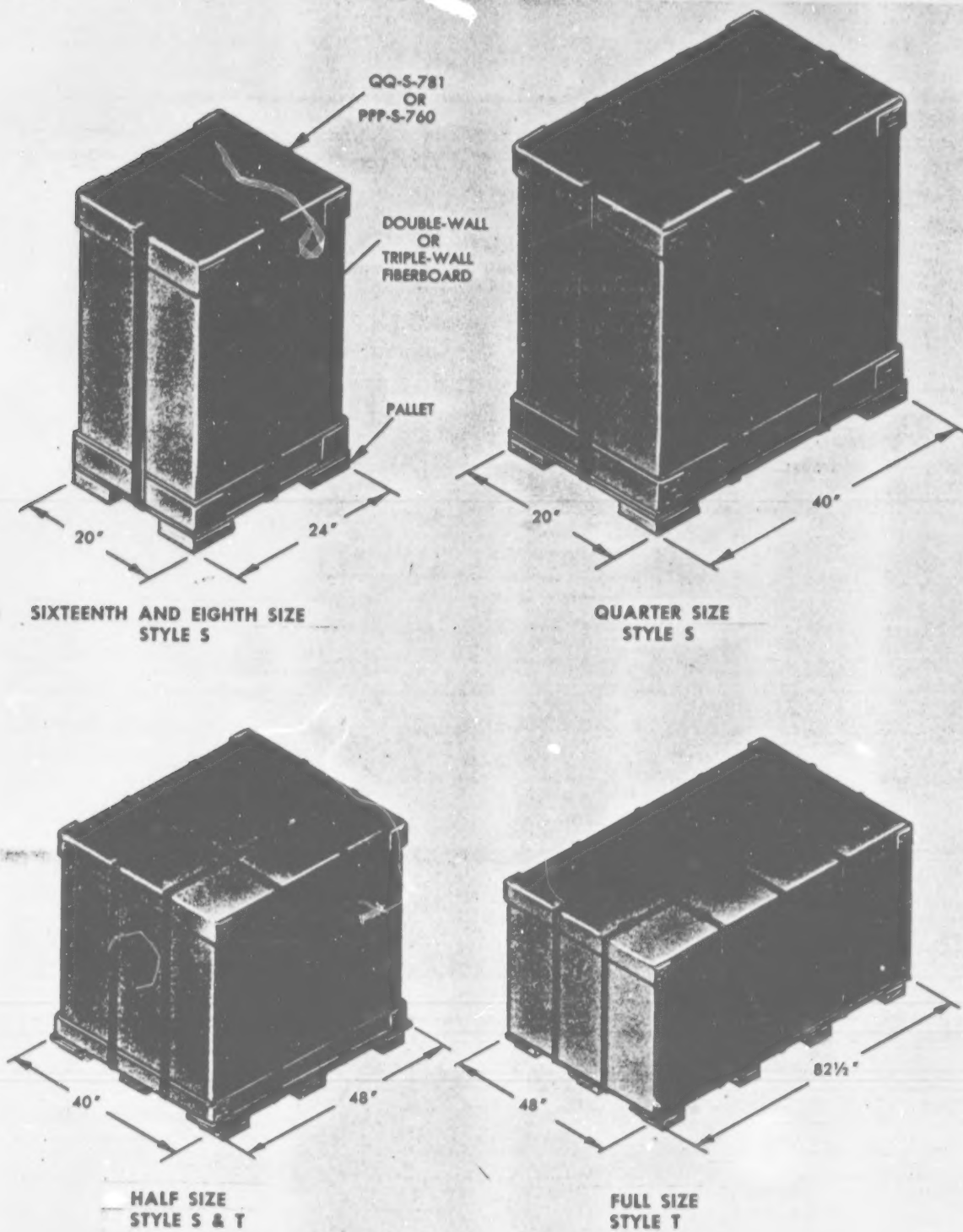


NOTE: USE NAILLESS FLAT STEEL STRAP CONFORMING TO QQ-S-781. SIZE 3/4" X 0.015"

[JMPTC 1273A]

Figure 7-7. Strapping of expendable fiberboard pallet boxes (MIL-P-26342).

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Figure 7-8. Box, consolidation, fiberboard (MIL-B-38721).

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d. Strapping Requirements. After the containers have been assembled and packed, they shall be strapped with $\frac{3}{4}$ -inch wide steel straps having a minimum thickness of 0.020 inches and conforming to Specification QQ-S-781, or with nonmetallic straps conforming to Specification PPP-S-760 of comparable tensile strength. Lengthwise straps shall first be applied, then girthwise straps (fig 7-8).

(1) Sixteenth and eighth size containers require one lengthwise and one girthwise strap.

(2) Quarter size containers require one lengthwise strap located in the center of the container, and two girthwise straps spaced one-third the distance between the ends of the container.

(3) Half size containers require two lengthwise straps spaced one-third the distance between the ends of the container and two girthwise straps.

(4) Full size containers require two lengthwise straps spaced approximately one-third the distance of the container width dimension, and three girthwise straps—one spaced approximately 18 inches in from each end and one in the center of the container.

7-7. Boxes, Shipping Insert Consolidation, MIL-B-43666 (General)

a. Description. These boxes are constructed of wood cleated plywood, plywood wirebound, double-wall fiberboard, or triple-wall fiberboard. They are mounted on pallet-type bases for ease of handling. Their construction varies widely depending upon the materials used. The sizes are such that they are modular in concept.

b. General Use. These boxes are intended for use as inserts in cargo transporters such as CONEX, MILVANS, or Seavans, or as separate exterior containers. They are to be used for Level A or B shipments.

c. Classification. There are three types of consolidation insert containers. Type I is of wood cleated plywood construction and has two styles depending upon the style of pallet base used. Type II is of plywood wirebound construction and has two styles depending upon the construction of the pallet base. Type III is constructed of double-wall or triple-wall fiberboard. Type III has four styles depending upon the construction features of the box.

d. Marking. The marking for shipment will be in accordance with MIL-STD-129.

7-8. Type I, Wood Cleated Plywood Consolidation Insert Box (MIL-B-43666)

a. Description. These containers are wood cleated plywood boxes similar in construction to the PPP-B-601 cleated plywood boxes. They are provided with a four-way entry pallet base (fig 7-9).

b. Use. These boxes may carry Type 1, 2, or 3 loads not exceeding a density of 37 pounds per cubic foot. Loads exceeding this density require additional box reinforcement. They may be used for domestic and oversea shipments. They are intended for consolidation of like and unlike stock numbered items. These containers may be used as inserts in SEAVANS or MILVANS, but should not be used as inserts in CONEX transporters.

c. Size and Weight Limitations. There are 21 sizes available in the wood cleated plywood consolidation insert containers. The outside length ranges from 30 to 88 inches. The outside width ranges from $31\frac{3}{4}$ to 45 inches. The outside height ranges from $21\frac{1}{2}$ to $52\frac{1}{2}$ inches. For MILVAN shipments, the overall height shall be not more than $41\frac{1}{2}$ inches. The weight capacity for the various sizes ranges from 1,000 to 2,600 pounds. Table I and II of MIL-B-43666 specifies the length, width, height, and weight combinations for each of the 22 sizes.

d. Closure. Nail the top to the sides using six-penny cement-coated, chemically etched, or mechanically deformed nails spaced three inches apart. Do not drive the nails into the end grain of the vertical cleats.

e. Strapping Requirements.

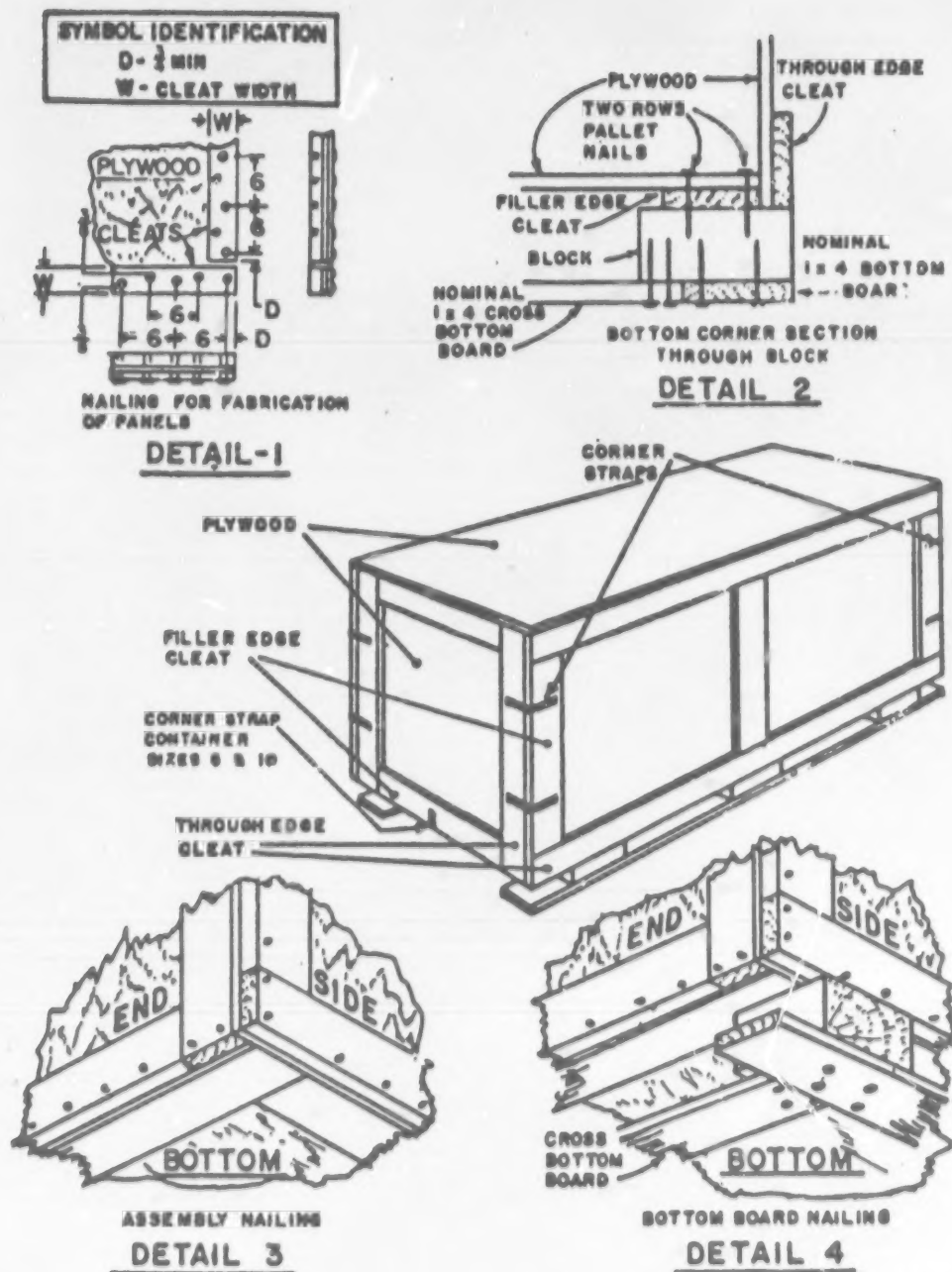
(1) Each vertical corner shall be reinforced with $\frac{3}{4}$ -inch flat steel strapping 0.023 inches thick.

(2) The strapping will be attached to the cleats with pneumatically driven galvanized staples $\frac{7}{16}$ inches long or with 1-inch long nails pneumatically driven.

(3) As an alternate, $\frac{3}{4}$ -inch wide flat, nail-on strapping, 0.025 or 0.028-inch in thickness, may be used. This strapping, which is perforated with holes spaced $\frac{1}{2}$ to $1\frac{3}{4}$ inches apart, may be secured with large headed galvanized roofing nails, zinc coated steel roofing nails, or 1-inch mechanically driven nails.

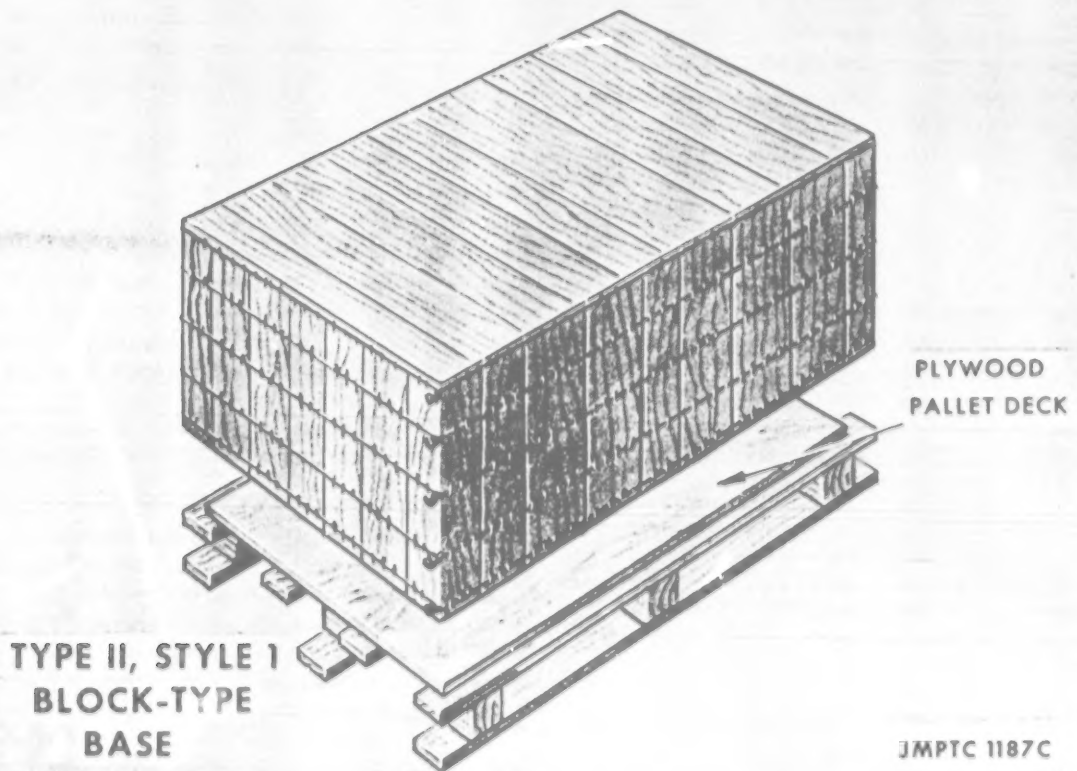
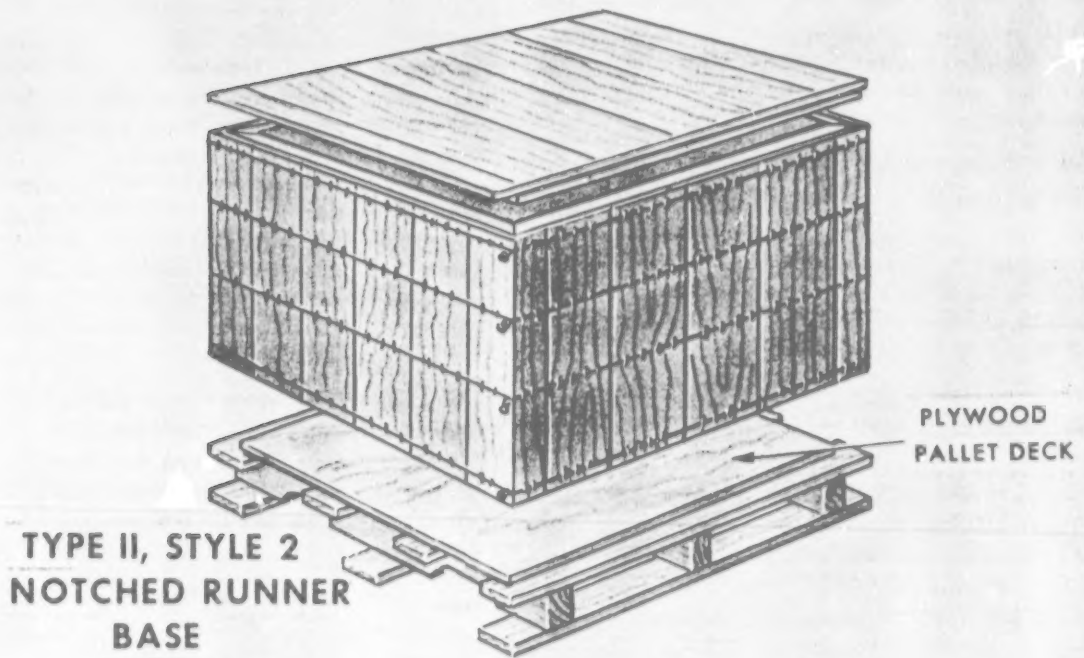
(4) Each strap will be secured with four fasteners. Two will be driven into the through cleat on the end of the box and two will be driven into the filler cleat on the side of the box.

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Figure 7-9. Type I, style 1, wood cleated plywood consolidation box (MIL-B-43666).



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Figure 7-10. Type II, plywood wirebound consolidation boxes (MIL-B-43666).

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(5) On boxes 43 inches high, strapping will be placed 13 and 26 inches from the top of the box.

(6) On boxes 21½ inches high, strapping will be placed 2 and 15 inches from the top of the box.

(7) On box sizes 5 and 10, which are 44 inches wide, an additional strap shall be placed at the center of each corner formed by the bottom and end panels.

7-9. Type II, Plywood Wirebound

Consolidation Insert Box (MIL-B-43666)

a. Description. The body and top of these boxes are constructed of plywood panels bound together with binding wires. The bottom panel is fabricated from ½-inch plywood which is secured to either a skid base or a pallet base (fig 7-10).

b. Use. The use of Type II plywood wirebound boxes is the same as Type I wood cleated plywood boxes.

c. Classification. There are two styles of boxes available under the Type II classification.

(1) Style 1 box utilizes a double-wing, block-type pallet base (fig 7-10).

(2) Style 2 box utilizes a skid base having three lengthwise skids which are cut out to facilitate side entry by forklift trucks.

d. Size and weight limitations. There are several sizes available in the plywood wirebound consolidation containers. The range of outside dimensions and weight limitations are approximately the same as those specified for the Type I, cleated plywood boxes. Tables I, and II, of MIL-B-43666 specify the length, width, and height combinations for each of the sizes.

e. Closure. After the box body is assembled by securing the wire loops with a sallee closure hand tool, or similar suitable alternate tool, and nailed to the base, make the closure by nailing the plywood top to the top cleats with threepenny nails. Space the nails 4½ inches apart. Complete the closure by applying lengthwise and girthwise straps.

f. Strapping Requirements. Requirements for the size, number, and location of straps vary for each style and size of Type II containers. Consult the Appendix of MIL-B-43666 for detailed requirements for reinforcing the particular plywood wirebound container being used.

7-10. Type III, Fiberboard Consolidation Insert Box (MIL-B-43666)

a. Description. These boxes are made of double-wall or triple-wall fiberboard. The box design and

construction differs for each of the four designated styles. Unless otherwise specified, they are furnished with a pallet base.

b. Use. Type III fiberboard insert boxes should be restricted to CONEX, MILVAN, or SEAVAN when used for level A oversea shipments. They may be used as shipping containers for Level B oversea shipments and as domestic consolidation containers. Type III boxes are intended to carry Type 1, 2, and 3 loads not exceeding a density of 37 pounds per cubic foot. Loads exceeding this density require additional box reinforcement. Style 1 should be used for items of assorted stock numbers to be loaded at origin as inserts only for shipment in CONEX, MILVAN, and SEAVAN to a single consignee address code.

c. Classification. There are four styles of boxes available under Type III classification.

(1) Style 3, regular slotted box (RSC), is similar to the regular slotted container available under the PPP-B-636 fiberboard box specification, except that one outer flap slightly overlaps the other (fig 7-11). The box may be furnished with or without a pallet base. When a pallet base is used, it may be either a double wing block-type or double wing notched runner-type.

(2) Style 4 half slotted container (HSC) with telescoping sleeve and cap, consists of a half slotted container bottom section without top flaps, and a top cap which extends down six inches over the sleeve (fig 7-11). The requirements for the pallet base are the same as for Style 1.

(3) Style 5 flanged bottom tube with cap, pad, and pallet, consists of a fiberboard tube with 4-inch bottom flanges, a bottom pad, and a top cap which fits down over the body tube (fig 7-12). This style is furnished with a stringer type pallet base.

(4) Style 6, half slotted container (HSC) with cap and pallet base, consists of a body having a regular slotted bottom and a flanged top, a top pad, and a top cap (fig 7-12). Unless otherwise specified, it is furnished with a pallet base.

d. Size and weight limitations. There are several sizes available in the fiberboard consolidation containers, depending upon the styles. The outside length ranges from 30 to 88 inches. The outside width ranges from 31¾ to 45 inches. The outside height ranges from 21½ to 52½ inches. The weight limit ranges from 1,000 to 2,600 pounds. Style 3 is available in sizes 1 through 10; Style 4 is available in sizes 23 and 24; Style 5 is available in sizes 16, 17, 18, and 24; and Style 6 is available in sizes 14 and 15. Tables I and II of MIL-B-43666 must be consulted for the various length, width, height, and weight

combinations of each of the sizes specified for Type III boxes.

e. Closure. The closure requirements vary for each style of box. Type III boxes are constructed in accordance with Specifications PPP-B-640, PPP-B-1163, and PPP-B-43666. The boxes are closed in accordance with the Appendix of the applicable specification.

f. Strapping Requirements. Either metal or non-metallic strapping may be used to reinforce Type III boxes. Requirements for the size, number, and location of straps vary for each style and size of box. Consult the Appendix of MIL-B-43666 for the detailed requirements for reinforcing the particular style and size of fiberboard consolidation box being used.

7-11. Packing Consolidation Container

a. Problems Involved in Consolidation. The main

problem involved in consolidation of materials becomes one of shock mitigation.

(1) The packer must be skilled in placing packages in the container so that each package "wedges in" other packages.

(2) The packer must be able to block or brace the load as he progresses, in a minimum of time and with the cheapest and lightest material, yet strong enough to do the job.

(3) Essentially, the problem becomes one of converting a type 3 load to a Type 2 load for protection against shock and vibration.

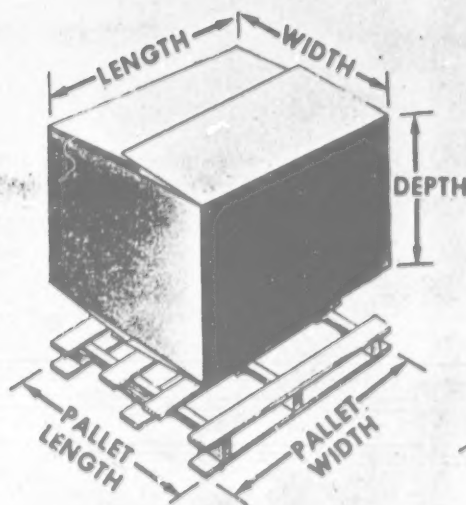
b. Shock Mitigation. In order to meet the problem of shock mitigation relative to consolidation containers, there are certain basic procedures to follow:

(1) Try to maintain level layers.

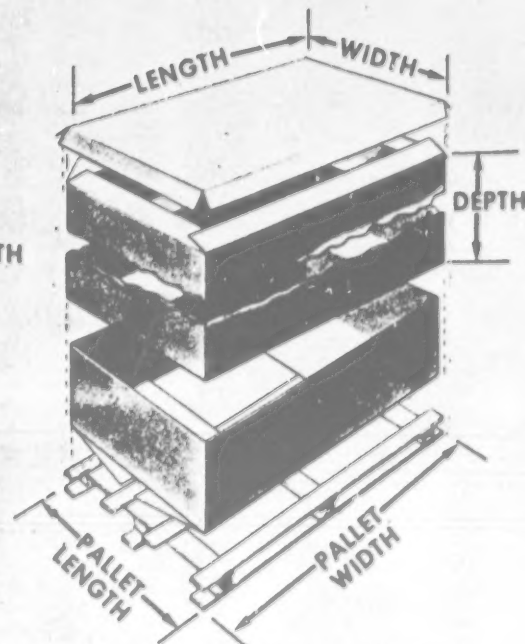
(2) Fill all internal voids as the load progresses.

(3) Keep the center of gravity low and cen-

CONSOLIDATION BOXES (MIL-B-43666)



TYPE III, STYLE 3,
REGULAR SLOTTED BOX

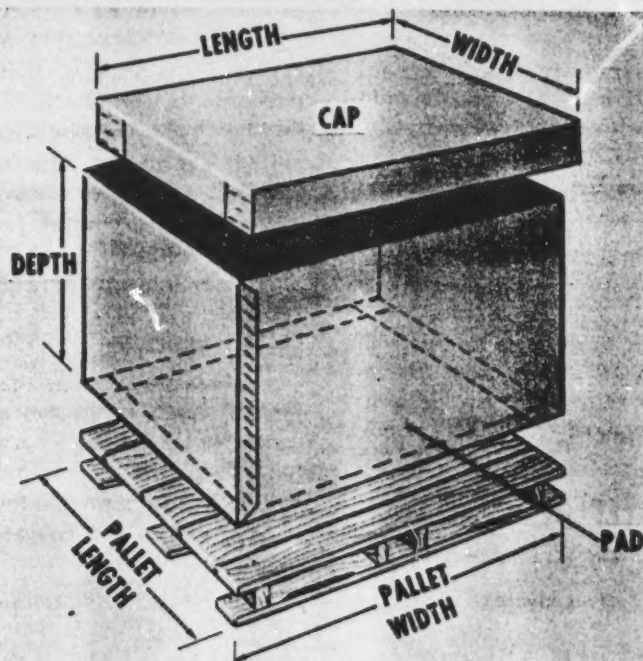


TYPE III, STYLE 4, HSC WITH
TELESCOPING SLEEVE AND CAP

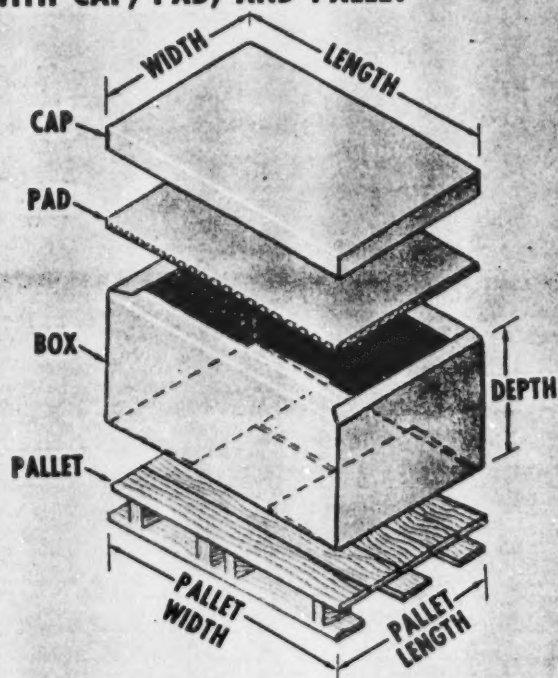
JMPTC 1188C

Figure 7-11. Type III, styles 3 and 4, fiberboard consolidation boxes (MIL-B-43666).

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TYPE III, STYLE 5, FLANGED BOTTOM TUBE WITH CAP, PAD, AND PALLET

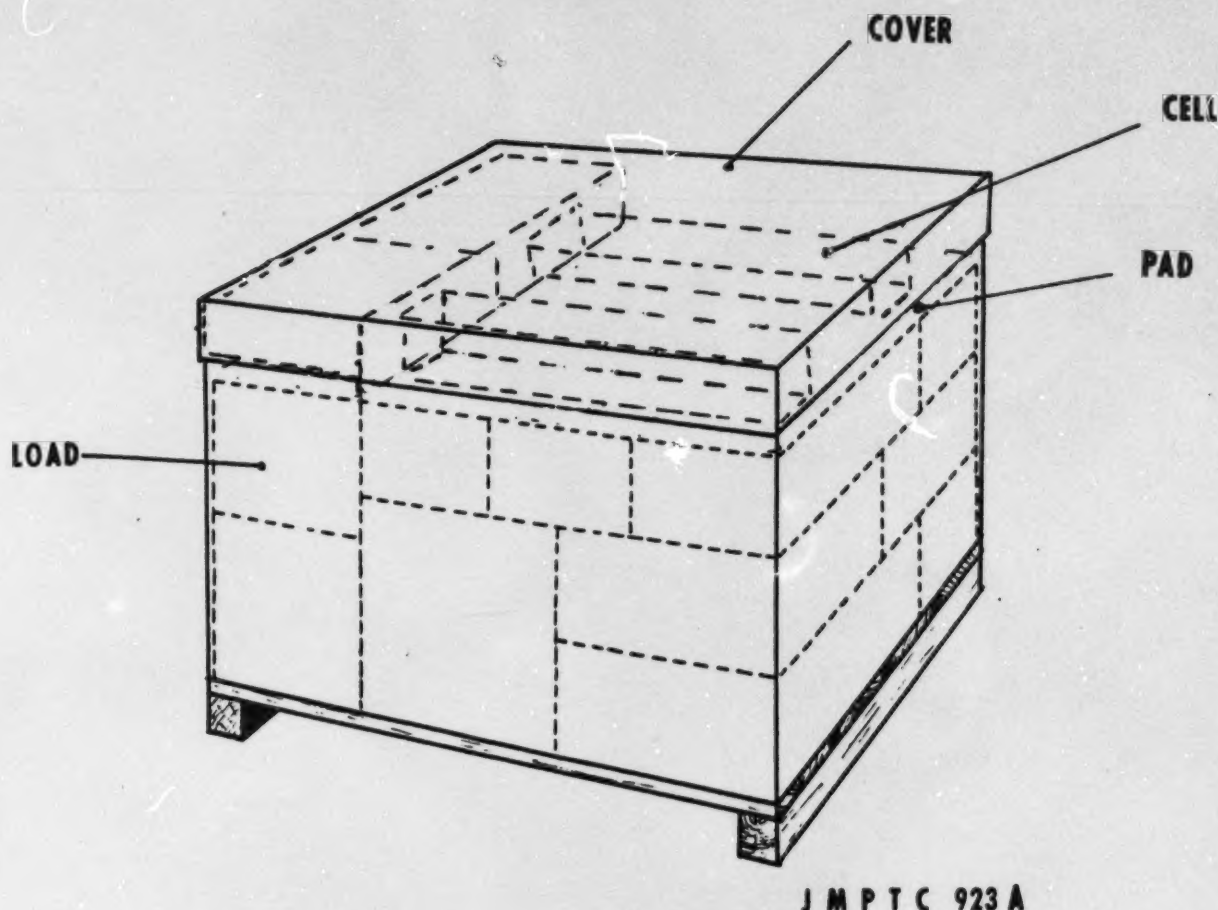


TYPE III, STYLE 6, HALF SLOTTED CONTAINER WITH CAP AND PALLET BASE

JMPTC 1879 B

Figure 7-12. Type III, styles 5 and 6, fiberboard consolidation boxes (MIL-B-43666).

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Figure 7-13. Blocking and bracing top voids.

tered by placing heavy items in the bottom portion of the container and centering them in the container as much as possible.

(4) Block and brace the interior load adequately to prevent movement caused by shock and vibration.

c. Blocking and Bracing the Load.

(1) The ideal conditions for full utilization of consolidation containers is to tailor a container to the size of uniform interior packages. Of course, the required consolidation containers are generally of standard dimension and are not related to product package sizes.

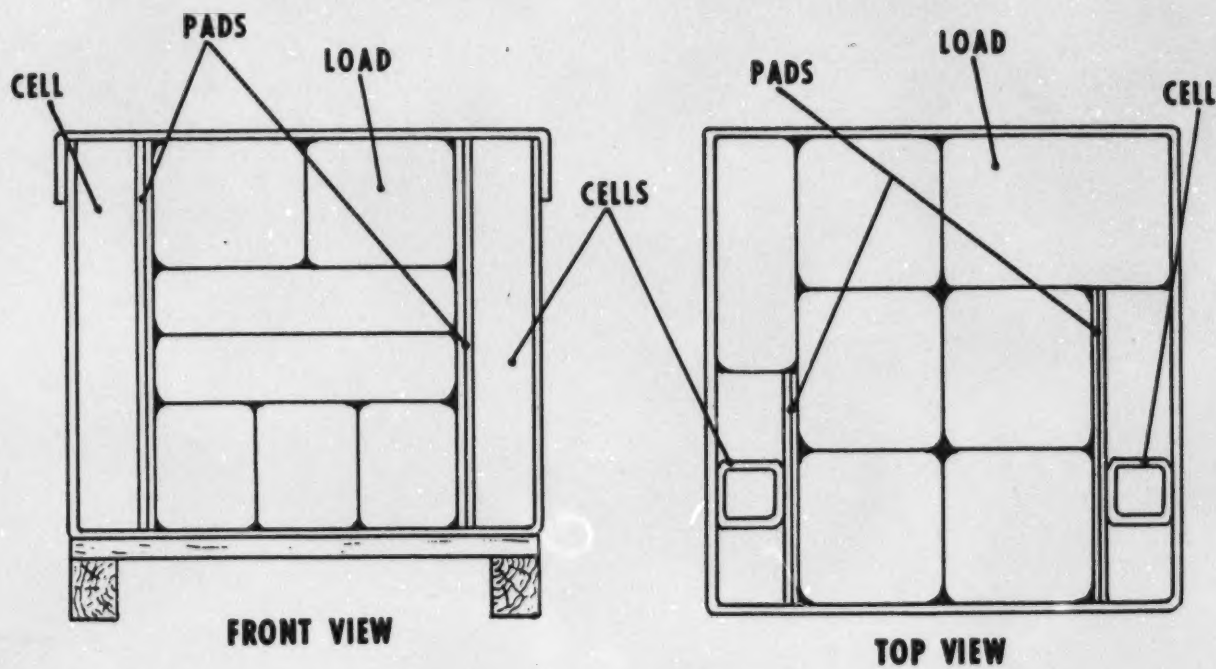
(2) These ideal conditions are not always present at the depot or base level, but with a variety of package sizes to place in consolidation containers most of the available space can be utilized in some instances.

(3) Voids that occur at the top of the pack are probably the most usual (fig 7-13). In order to provide holddown media for the load, first cover the packs with pad(s) and then place cells between the pads and the container cover. The use of adhesives will hold the cells in place. Cells should be located where strapping will be placed. Where feasible, the corners of the container may be split down to the top of the load and the excess portion of each side panel, above the top of the load, may be folded in, thus eliminating the need for cells.

(4) Voids that occur at the sides of the pack can be blocked with pads and cells, the same as top blocking and bracing (fig 7-14).

(5) Interior voids (fig 7-15) are the hardest to cope with and the most time-consuming. All voids that would permit shifting of the packages should be filled with cells or foamed-in-place materials as

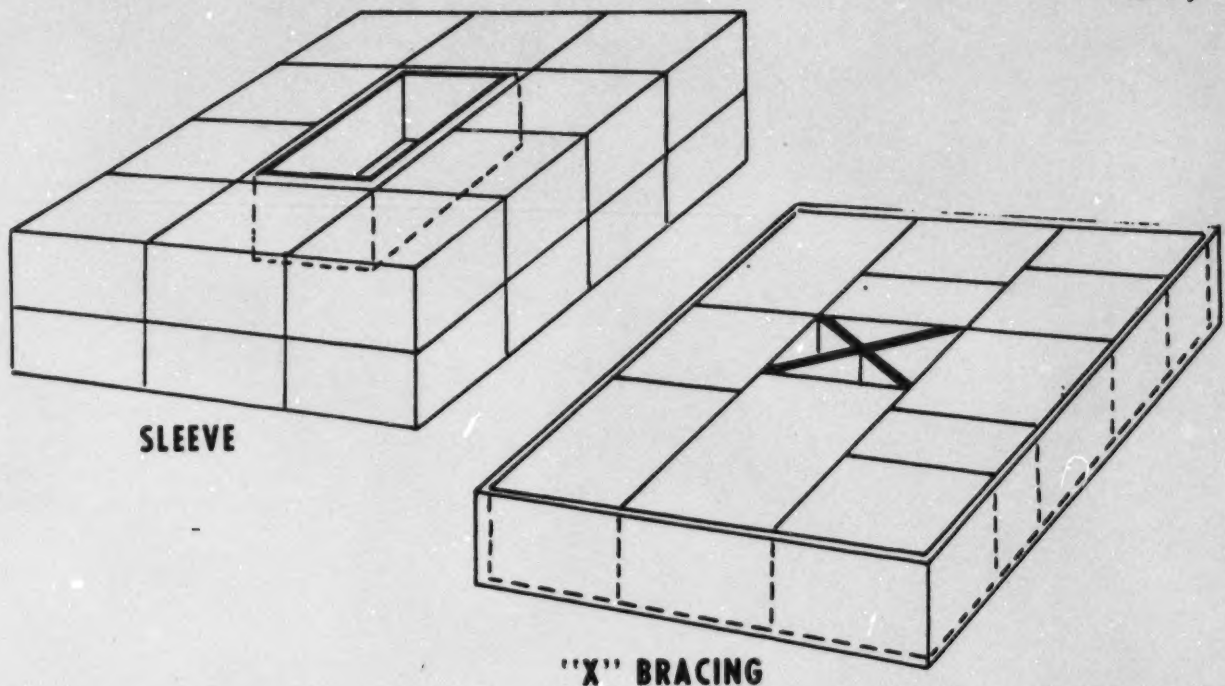
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J M P T C 924 B

Figure 7-14. Blocking and bracing side voids.

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JMPTC 925

Figure 7-15. Blocking and bracing interior voids.

the layers progress. If the packages are uniform, one sleeve may fill the void for several layers of packages.

(6) Compound voids (top and side, two sides, etc.) may take a little more skill, but pads and cells can be used to block and brace the same as previously discussed.

7-12. Packing Nonperishable Subsistence Items

Unit loads of nonperishable subsistence items shall be prepared in conformance with Specification MIL-L-35078, Load, Unit: Preparation of

Nonperishable Subsistence. This specification establishes patterns, methods, materials, and techniques applicable to the preparation of unit loads of nonperishable subsistence items by loading the shipping containers onto a pallet or within a consolidation container for shipment. Requirements for establishing unit loads and the selection of unit loads are specified in appendix I of Specification MIL-I-35078. Requirements for supplemental waterproofing of unit loads, which shall be applied when specified by the procuring activity, are specified in appendix II. The types and classes of unit loads are shown in table 7-5, below.

Table 7-5. Classification of Unit Loads of Nonperishable Subsistence Items (MIL-L-35078)

Types	Classes
I—Palletized unit load	A—Glued load. B—Glued load with cap and strapping. C—Glued load with sheathing, cap and strapping. D—Strapped load. E—Strapped load with sheathing and cap. F—Strapped load with cap.
II—Containerized unit load	A—Triple-wall corrugated fiberboard tube with cap, pad, strapping, and pallet base. B—Solid fiberboard box with liner, cap, strapping, and pallet base. C-1—Wood cleated plywood box with skid base and strapping. C-2—Wirebound plywood box with skid base and strapping. D—Double-wall corrugated fiberboard tube with cap, pad, strapping and pallet base.

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7-13. Cargo Containers (General)

a. Definitions.

(1) *Transporter*. A cargo container is a large shipping container in which packed or unpacked materiel is placed for movement to a break-bulk point or to an ultimate consignee.

(2) *CONEX*. The CONEX is a Government-owned noncollapsible, reusable metal shipping container equipped with skids and lifting lugs to facilitate handling.

(3) *MILVAN*. The MILVAN is a Government-owned or leased noncollapsible, reusable cargo container capable of being coupled to another container of like description. It can be lifted by top or bottom corner fittings; can be used either singly or coupled together; and can be carried by highway, rail or water modes of transportation.

(4) *SEAVAN*. A SEAVAN is a privately-owned container of various sizes and configura-

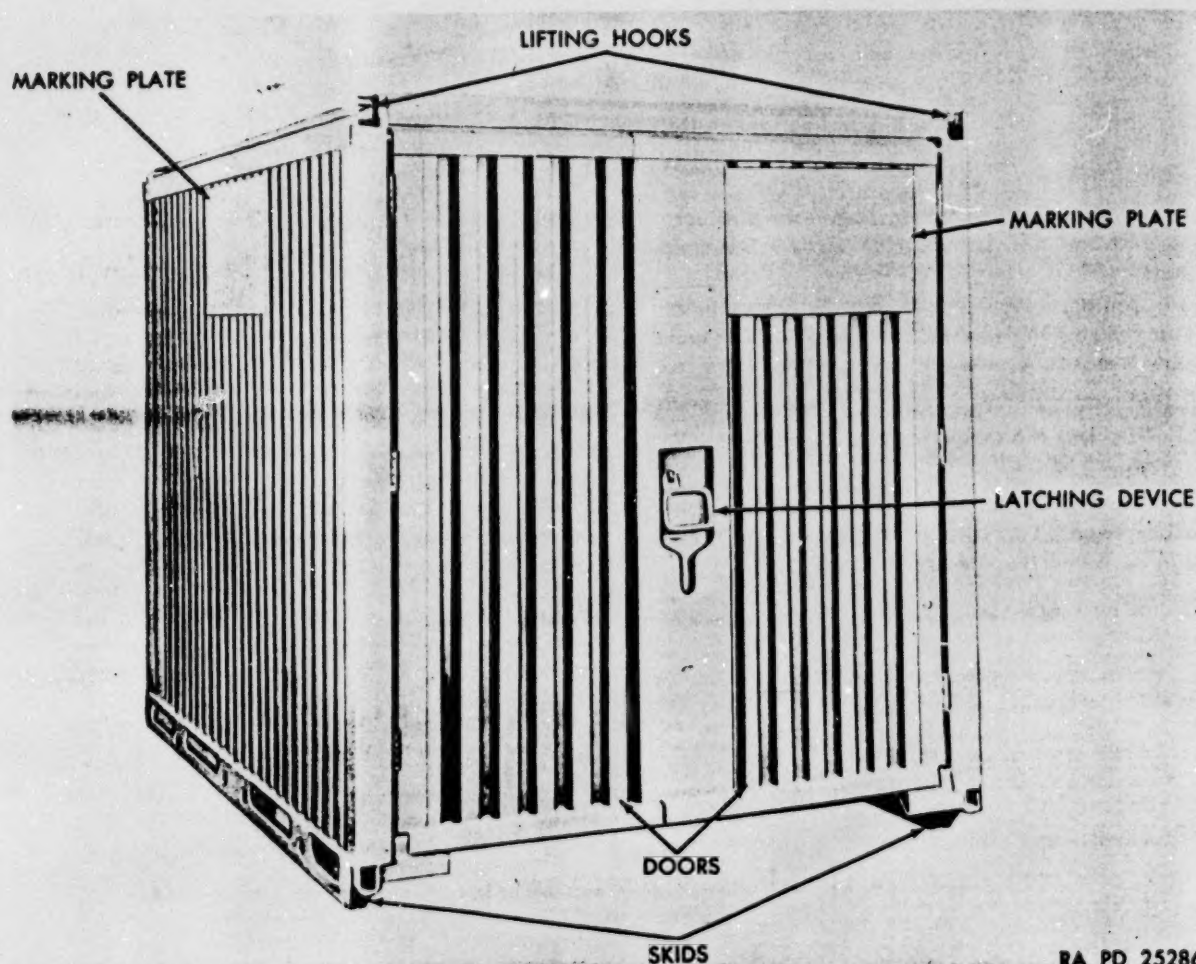
tions which may be leased to the Government for the consolidated movement of materiel by highway, rail, or water modes of transportation.

(5) *Stuffing*. The term "stuffing," as related to cargo containers means the placing of cargo into cargo containers as distinguished from the process of loading containers on board ship. See MTMC Pamphlet No. 55-2 "Management and Stuffing of Containers."

b. Purpose and Advantages of Large Containers.

(1) *Purpose*. The purpose of cargo containers reduce the number of miscellaneous small package shipments to unit loads of the best possible size for the direct application of mechanical handling equipment.

(2) *Advantages*. The use of mechanical handling procedures increases the speed, security, accuracy, flexibility, and economy of supply and transportation operations.



RA PD 252865

Figure 7-16. Type II CONEX.

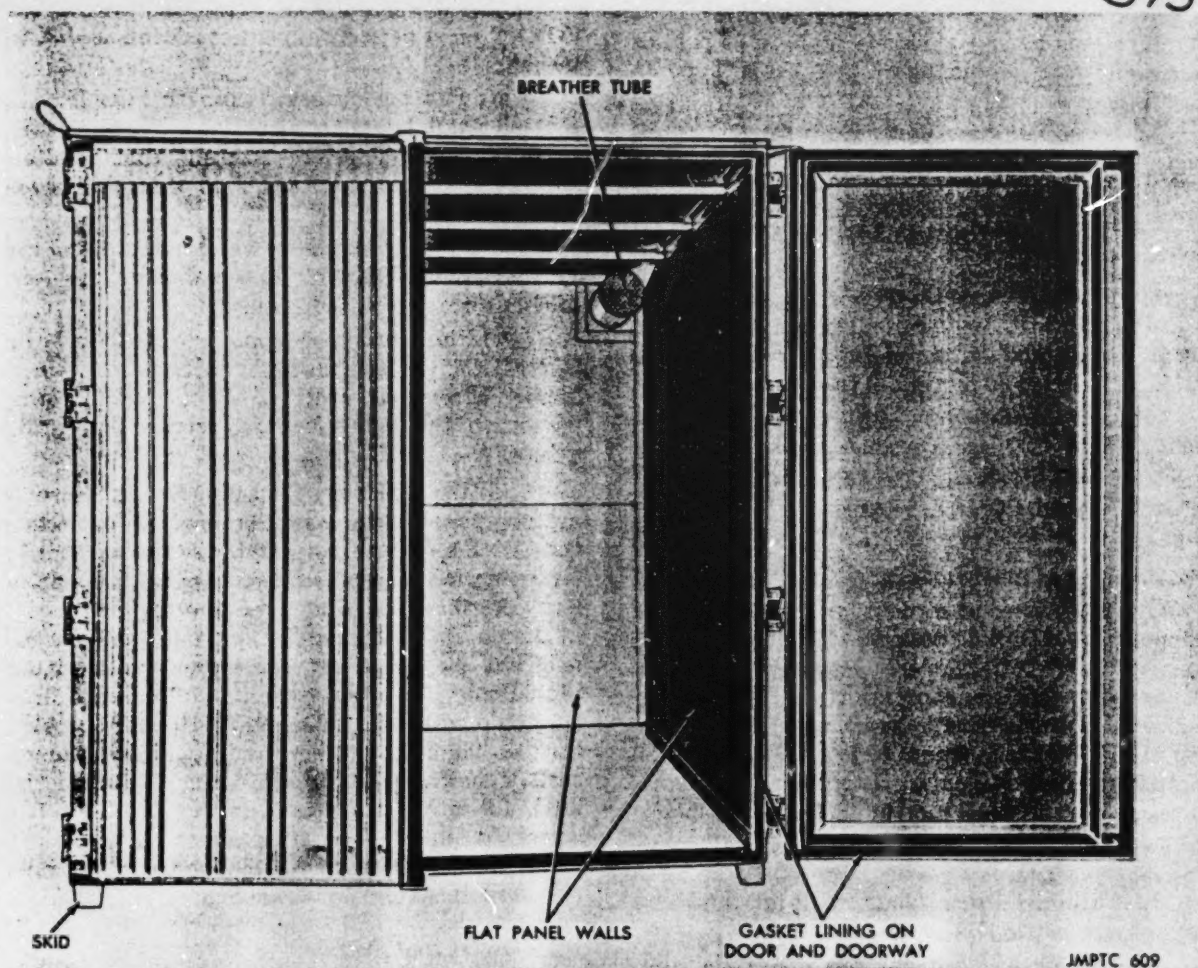


Figure 7-17. Controlled humidity (CH) CONEX.

(a) Use of cargo containers reduces the cost of handling and rehandling many small packages.

(b) Loss due to damage to containers and supplies during handling and shipping is reduced.

(c) Loss due to pilferaging and misplacement or misrouting of individual packs is reduced.

(d) The consolidation of packs within cargo containers reduces the need for marking and documentation of individual packs destined for one consignee.

(e) Savings are realized through the elimination or reduction of heavy or expensive shipping containers.

7-14. Use of CONEX Containers

a. *Description (fig 7-16 and 7-17).* The CONEX cargo containers are reusable metal shipping containers. With the exception of those which are

designed to offer controlled humidity, they are weatherproof but not entirely waterproof. There are two types of CONEX containers.

(1) *Type I (Half-Size).* This type is four feet, 3 inches long and has a volume of 135 cubic feet. It has a weight carrying capacity of 9,000 pounds.

(2) *Type II (Standard Size).* This type is twice as long as the Type I. It has a volume of 295 cubic feet and has a carrying capacity of 9,000 pounds also.

(3) *Type II (Controlled Humidity).* Type II is also available in an airtight type construction which makes it water-vaporproof. It is provided with a free-breathing device which is connected to a desiccant cell. The desiccant cell breathes freely with temperature changes. All air entering or leaving the CONEX must pass through the desiccant, thus maintaining a safe level of relative humidity within the CONEX.

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b. Utilization of Weight Capacity.

(1) Items having a density of 30 to 45 pounds per cubic foot should be shipped in a Type II CONEX.

(2) Items having a density of over 45 pounds per cubic foot should be shipped in a Type I CONEX.

(3) The contents of CONEX containers shall not exceed 9,000 pounds.

c. Utilization of Cubic Capacity.

(1) The maximum use of all internal space will normally preclude the use of dunnage. A workable guide is to utilize 80 percent of the usable space.

(2) Unnecessary dunnage adds to the gross weight of the CONEX. Eliminate it when possible.

(3) Large, irregular shaped items should not be stuffed in a CONEX because of the waste of cube.

d. Stuffing of Hazardous Materials

(1) Authorized hazardous materials may be shipped in a CONEX provided they are packed, marked, and stuffed in strict accordance with Department of Transportation and US Coast Guard regulations. Examples of materials prohibited by the US Coast Guard to be shipped in cargo containers alcohol, bombs, detonators, dynamite fuzes, gas projectiles, mortar ammunition, black powder, hand grenades, mines, rocket missiles, etc.

(2) Authorized hazardous materials must be kept separated from the rest of the load.

(3) Noncompatible hazardous materials must be kept separated in shipment.

e. General Rules for Stuffing CONEXES.

(1) *Sensitive and expensive items.* Stuff sensitive and expensive items in the rear of the CONEX to deter pilfering.

(2) *Heavy, rugged items.* Place heavy and more rugged items on the bottom in the CONEX. When necessary, block and brace these items to prevent shifting and damaging other items.

(3) *Sets and assemblies.* Whenever possible keep sets and assemblies together within the CONEX to facilitate keeping them together when the CONEX is unstuffed.

(4) *Items to be shipped to different consignees.* Whenever possible, if items within the CONEX are to be shipped to different consignees, they should be kept together and separated from the rest of the load.

(5) *Priority items.* Whenever possible, plan to load so that priority items will be readily available upon arrival at destination.

(6) *Securing the load.* The load within the CONEX must be secured so that it will not shift in transit.

(a) Place packages within the CONEX so that all available space is utilized. Prevent shifting of containers by cross-tiering, that is alternately fitting them together so that the boxes support each other.

(b) Place dunnage between the load and the sides of the CONEX to fill voids when the containers cannot be fitted snugly.

(c) Block and brace partial loads within the CONEX to prevent shifting by placing 2- by 4-inch lumber across the width of the CONEX, fitting the ends of the braces into the corrugations on the sides of the CONEX.

(d) Use flat steel strapping in the doorway area to prevent the load from spilling out when the CONEX doors are opened. Use two lengths of strapping for each application. Anchor one end of each length by threading the end through a slot in the doorpost, looping the end back against the length of the strap, and securing with a strapping seal. Bring the other two ends of the anchored lengths together at the center of the load, tension the two lengths together, and apply a strapping seal. If strapping is not sufficient to secure the load, fill the intervening spaces between the straps by placing additional strips of wood dunnage vertically or horizontally beneath the straps prior to tensioning the strapping.

f. Closure and Sealing.

(1) *Weatherproofing the doorway area.* Since the CONEX is not completely waterproof, secure waterproof barrier material in the doorway area when there is a danger that water may damage the contents in the CONEX.

(2) *Placing the shipping documents within the CONEX.* Place the shipping documents in a shipping document envelope and place the envelope in the packet located in the CONEX door, so that it is easily accessible when the CONEX is opened.

(3) *Closing the CONEX doors and securing the handle.*

(a) Close the CONEX doors and lock them in the closed position by turning the door handle 90° so that the hole in the handle is in line with the hole in the bracket which is located on the CONEX door.

(b) Secure the door handle with zero to five gage wire. Pass the wire through the holes in the door handle and the door bracket. Thread the wire through two holes drilled an inch apart in an 18-to-20-inch steel bar. Twist the bar several times,

MILVANS COUPLED FOR TRANSPORT

WEIGHT AND CUBE DATA

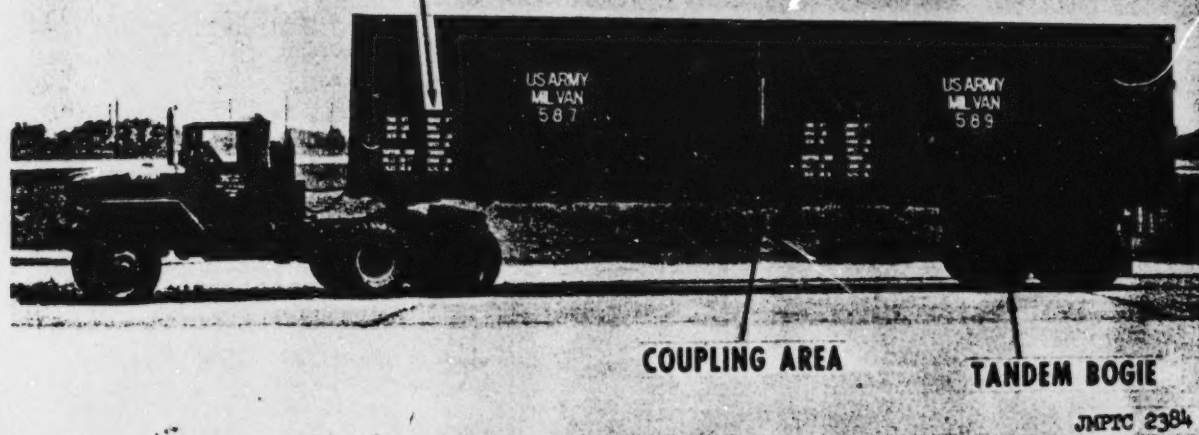


Figure 7-18. MILVAN cargo containers.

remove the bar, and cut off the surplus wire close to the twist with a bolt cutter.

(c) A padlock may be used in lieu of the wire when authorized. Care must be taken to insure that the consignee has the means to open the lock upon arrival.

(4) *Applying the seal to the door handle.*

(a) Make sure that the serial number on the seal corresponds with the number recorded on the shipping document.

(b) Thread a standard railway car seal through the slot in the door handle and the slot in the bracket which is located on the CONEX door.

(c) Thread one end of the seal into the locking device on the seal and snap into place.

g. Marking.

(1) *Location of markings.* Exterior marking plates are located on each side and on the front and rear of the CONEX. Address markings will appear only on these plates.

(2) *Obliterating old markings.* Obliterate old markings on the marking plates by repainting them.

(3) *Requirements for marking.* Markings on CONEXES must conform to MIL-STD-129, and to MILSTAMP/MILSTRIP requirements.

(4) *Applying the markings.* Apply the markings on the address plates in colors which contrast with the background, so that they can be read easily from a distance.

7-15. Use of MILVANS and SEAVANS

a. *Description of MILVAN (fig 7-18).* A MILVAN has inside dimensions of 231 inches in length, 92 inches in width, and 87 inches in height. The gross weight rating for each 20-foot container is 44,800 pounds. A MILVAN can be coupled to another MILVAN container to make a single unit 40 feet in length. A MILVAN has the capability of being moved by a semitrailer tractor when used in conjunction with a tandem bogie arrangement which serves as the rear wheels. When the double doors are properly closed, the MILVAN affords waterproof protection.

b. *Description of SEAVAN (fig 7-19).* SEAVANS vary from approximately 20 to 40 feet in length. The standard length utilized by the military is 40 feet. SEAVANS are 8 feet in height and 8 feet in width. They have a maximum gross weight capacity of 67,200 pounds. SEAVANS are compatible for movement by motor and rail and may be stored for shipment on specially containerized ships. They may be transported on a semitrailer

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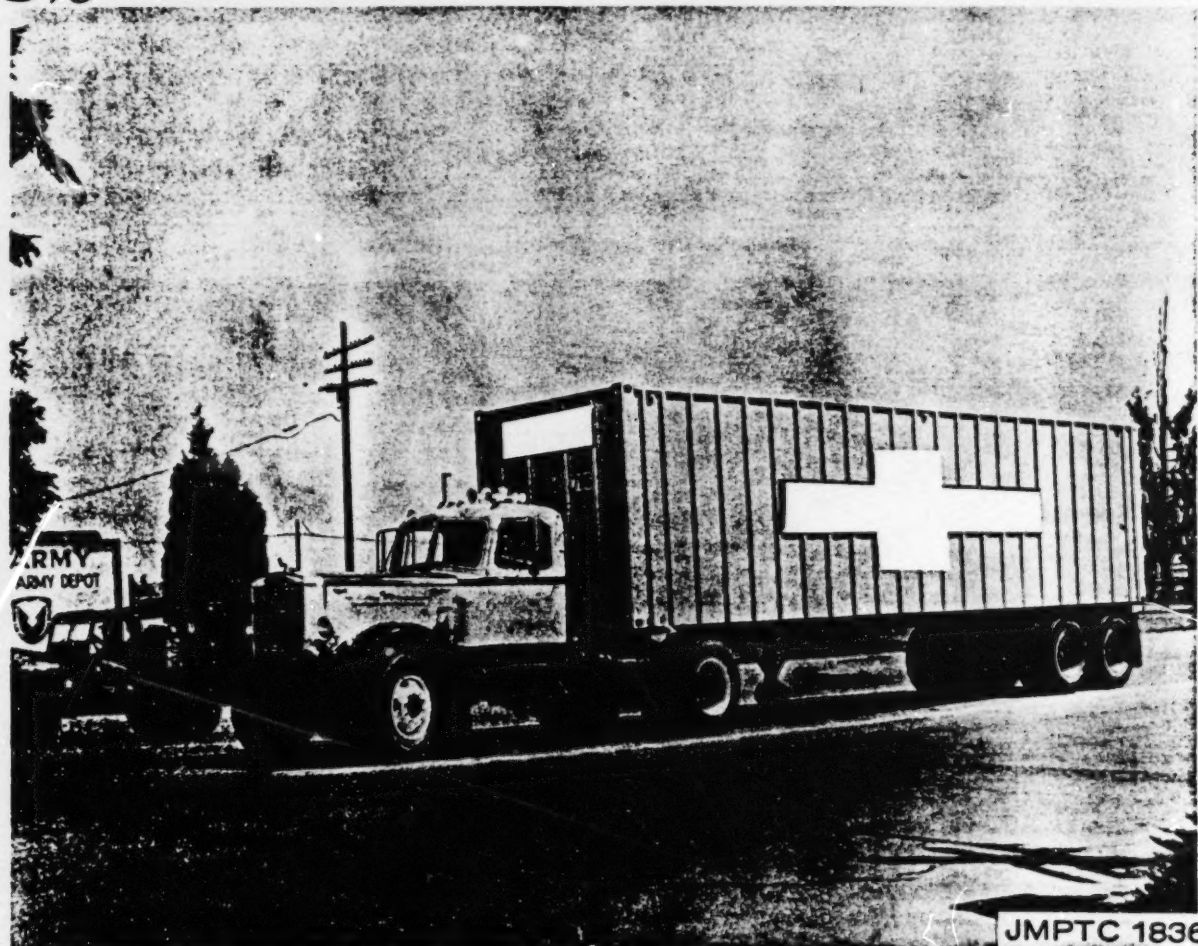


Figure 7-19. SEAVAN loaded for highway movement.

chassis and are lifted easily and loaded, minus the chassis, on board by modern materials-handling equipment. There are four general types and three specialized types of SEAVANS:

(1) *Dry cargo container.* The dry cargo container is weatherproof and is designed to protect the cargo from water. It is ideally suited for shipping items packed in domestic packs and any commodities susceptible to water damage. The dry cargo container is completely inclosed and must be loaded and unloaded by hand or forklift truck.

(2) *Dry cargo—canvas top container.* The canvas, or so-called "rag" top container, is similar to the dry cargo container, but has a removable canvas top. With the top removed, the cargo can be loaded and unloaded by crane as well as forklift. Canvas top containers are not 100 percent weatherproof; therefore, all items loaded in such containers must be in waterproof packs or otherwise not be susceptible to water damage.

(3) *Flatrack container.* The flatrack container resembles a flatbed truck with varying styles of side bracing and corner posts. Generally, the flat rack has about two-thirds the cubic capacity of a dry cargo container, but with the same weight capacity. It is designed to carry high density and oddly shaped cargo that requires little protection against the elements. Brackets on the sides of the bed facilitate efficient tiedown or banding of heavy items to the bed of the container. Open sides and ends facilitate the loading and unloading by crane or forklift truck.

(4) *Reefer (refrigerator) container.* Perishable cargo that must be refrigerated or frozen must be transported in a reefer. Most of the commercial reefers have standard refrigeration units that are fuel operated for road use and electrically operated for storage or ocean transit. The standard container can refrigerate or freeze from ambient temperature to -10 degree Fahrenheit.

(5) *Insulated container.* This is a specialized container. It is used for cargo that should not be subjected to rapid temperature changes. It should be used when extreme changes in ambient temperatures are indicated.

(6) *Car-carrier.* This specialized container is designed to carry two or four privately-owned vehicles for ocean transportation. The container which carries four vehicles is 35 feet long and has double-deck frames. Due to its additional height, the four vehicle container has one and one-half times the cube capacity of a dry cargo container.

(7) *Tank container.* This also is a specialized container. It is a small tank, inclosed in a framework, that can be used for small lot shipments of bulk liquids.

c. Weight Distribution.

(1) Distribute the load evenly throughout the container with heavier items on the bottom.

(2) Cargo must be compatible with the size of the container. When the density of one commodity is not compatible with the container size, select an adequate commodity mix that will yield the best cube utilization. At least 80 percent of the cube should be used.

d. Weight Limitations. There are two overall transporter-weight limitations: First, the rated capacity of MILVANS and SEAVANS; and second, the road-weight limitation imposed by the States over which the container must travel by motor vehicle.

e. Shipment of Hazardous Materials.

(1) Hazardous materials must be compatible with the remainder of the load. Do not stuff food or medical supplies in the same container as insecticides, chemical products, radioactive materials, biological materials, poisons, or toxic materials.

(2) Do not ship noncompatible hazardous materials together.

(3) Pack, mark, label, and placard hazardous materials in strict accordance with Department of Transportation and US Coast Guard regulations.

(4) The US Coast Guard regulations prohibit certain explosives and other hazardous materials from being shipped in cargo containers. These include, but are not limited to, those mentioned in discussing the stuffing of CONEXES.

f. General Rules for Stuffing MILVANS and Seavans. The general rules discussed below concern the stuffing of general cargo into MILVANS and dry cargo type SEAVANS.

(1) Place heavy items on the bottom of the

load, maintaining an even distribution of weight throughout the cargo container.

(2) When stuffing standard 43-inch high modular containers, double-tier them whenever possible. If double-tiering is not possible, top off the load with "fluff cargo" of low density. "Fluff cargo," which must be man-handled, should not exceed 200 pounds per item or pack.

(3) Leave several inches of head space between the top of the load and the top of the cargo container that the load can be removed easily with a forklift truck.

(4) Pack the load as tightly as practicable. Do not wedge the load or pack it so tightly that problems will occur during unstuffing operations.

(5) Always position palletized or skidded loads to rest on their pallets or skids. Face pallet access slots toward the doors to minimize forklift maneuvering during unstuffing operations.

(6) Never place a heavy crate or box so that it rests on top of, and inside the four corners of the box beneath it. Place dunnage over the lower level of containers when dense loads in the upper tier may cause damage to the containers below.

(7) Place boxes, crates, and cartons, which contain liquids that may leak, on the bottom of the load whenever practicable.

(8) Keep drums that contain petroleum products separated from general cargo. Stow drums with their bungs on top. Pack the drums tightly. When possible, palletize drums. When not palletized, place strips of dunnage between tiers of drums.

(9) Use lumber, burlap, fiberboard or paper, as applicable, to protect the cargo and to prevent it from shifting during transit. Use dunnage when it is available for filling spacing between large boxes or crates.

(10) A load checker should keep a running account of the weight of individual items being stuffed to ensure the correct total net weight. Enter the overall load weight and cube on the loading list or the Transportation Control Movement Document (TCMD).

(11) Brace cargo of average or high density to prevent it from falling out when the container doors are opened.

g. Closing and Sealing MILVANS and Seavans. Place the shipping documents in the space provided on the door. Make sure that both rear doors on MILVANS and SEAVANS are closed by sliding the closure bolts into the holes provided in the body of the cargo containers. Position the door handles over the latches in the doors and

attach a numbered railway car seal. MILVANS require that both door latches are provided with a seal.

(1) Make sure that the serial numbers on the seals correspond with the numbers on the shipping documents.

(2) Thread the seals through the latches on the doors and snap the seals into the seal locking devices.

(3) Use padlocks of approved design on cargo container containing classified material. Be sure that key control measures are provided.

h. Marking of MILVANS and SEAVANS. Shipment units and shipment units in consolidation will be address marked in accordance with Military Standard MIL-STD-129, Marking for Shipment and Storage. The address markings for MILVANS and SEAVANS shall be accomplished by attaching a waterproofed Military Shipping Tag (DD Form 1387-1) adjacent to the seal, if required, or at the rear of the van. Data for the tag will be in conformance with DOD 4500.32R, Military Standard Transportation and Movement Procedures (MILSTAMP) and MIL-STD-129.

APPENDIX

NATIONAL STOCK NUMBERS

1. General

The selection of the proper items of supply for use in military preservation, and packing operations is of vital importance. This selection must be made in accordance with requirements established on commodity and process specifications and other official publications. Items of supply are designated by name, type, class, style, grade, size, color, length, width, etc. The difference of an item in any of these respects from any other item, establishes it as a separate and distinct item of supply. These distinct items must be used as specified to properly perform preservation and packing processes and methods. To make proper selection possible, the Federal catalog system is designed to classify, describe and assign one, and only, one, National stock number to each item of supply. The listing of classifications, descriptions and National stock numbers for the hundreds of items used in preservation and packing, and appearing in the Federal supply catalog is beyond the scope of this manual. The purposes of this appendix is to emphasize the importance of stock numbers in the military supply system and to furnish general information concerning their structure and use.

2. Composition of the National Stock Number

The National stock number (NSN) is composed uniformly of 13 digits and is always written in a 4-2-3-4 format. The first four digits (8105) are the Federal Supply Classification Code (FSC) and the last nine digits (00-290-0345) are the National Item Identification Number (NIIN). The whole National stock number is never separated to run into a second line.

a. Federal Supply Classification. The Federal supply classification is used to classify items of supply identified in the Federal catalog system. It is designed to include all items known to be in the supply system of the Federal Government. Of the four digit code (8105) used to identify Federal

supply classifications, the first two digits identify the broad *Group* of material. Group 81 covers containers, packaging, and packing supplies, and the last two digits identify a particular *Class* within the group. Class 05 covers bags and sacks. Other examples of Federal supply classifications are as follows:

FSC	Group	Class
	55	30
5530 ----	(Lumber, millwork, plywood, and veneer.)	(Plywood and veneer).
	81	(15)
8115 ----	(Containers, packaging and packing supplies.)	(Boxes, cartons and crates).

b. National Item Identification Number. The last nine digits of the National stock number comprise the National Item Identification Number. This number serves to differentiate each item of supply from all others within its *Class*. In the example above, the NIIN 00-290-0345 identifies a 9½ x 14½ paper cushioned shipping sack, conforming to sacks in the 05 *Class*. Each item of supply has one, and only one, National item identification number, and each National item identification number applies to one, and only one, item of supply. The National item identification numbers are assigned serially without regard to the name of the item, its description, or its classification. The National Codification Bureau code (NCB) is represented by the first two digits in the NIIN.

3. Breakdown of the National Stock Number

a. For clarification purposes the following is a breakdown of another National stock number related to a common packing material.

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FSC	NIIN
8 1 1 5-	00-753-4691
	NCB
	Code

GROUP 81	CLASS 15	ITEM 00-753-4691
Packaging and Packing Supplies.)	(Boxes, Cartons and Crates.)	Fiberboard, Triple-Wall, PPP-B-640, length 58 inches, width 35-7/8 in., depth 28- 1/2 in.).

b. The NSN is part of the NATO numbering system. The US will use 00 and 01 for the first 2 digits of the NIIN.

c. If the first 4 digits are followed by 00 the number is a former FSN. If the first 4 digits are followed by 01 the number indicated a new item.

4. Use of National Stock Numbers

Items of supply for use in preservation and packing operations are of wide range and appear under several classification codes. These codes cover cleaning materials, preservatives, barriers, tapes, adhesives, cushioning materials, various types of equipment, marking materials, fasteners, interior containers, exterior containers, and many other groups and classes. Oftentimes, there are several classifications covering general groups of

items. National stock numbers are assigned to each specific item under each classification in accordance with item name and specific characteristics. When selecting items and materials which meet the requirements of preservation and packing specifications and directives, identification is accomplished by reference to titles and descriptions appearing in the Federal supply catalog. The following are representative examples:

National Stock No.

8135-00-171-1559

Description

Barrier Material, Waterproofed, Flexible: components and wt per 500 24-by 36-in. sheets, paper 30 lb. asphalt 50 lb, paper 30 lb; 200 yd roll, Fed PP-B-1055, class C-1; for interior wraps.

8135-00-558-0823

Cushioning Material, Packaging: cellulose wadding; water-resistant; low absorbency; 66 ft. long, 20 in. wide, 1 in. thick; Specification PPP-C-843, type II, class B.

5. Sources of National Stock Numbers

National stock numbers are listed in Federal supply catalogs published by the Defense Logistics Agency. Stores stock catalogs published by General Services Administration contain numbers and descriptions of items handled by this agency. Federal and military commodity specifications indicate Federal supply classification codes only.

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